MS-117 VOL. 1
SECTIONS I THROUGH V

project
mercury

OPERATION AND MAINTENANCE

ACQUISITION SYSTEM POINT ARGUELLO

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WARNING

The equipment described in this manual employs voltages which are dangerous. Use appropriate caution when working on this equipment.

Figure 1-1. Locations of Project Mercury Sites

SECTION I
GENERAL DESCRIPTION

1-1. GENERAL INFORMATION

A. SCOPE OF MANUAL

This publication comprises operating and maintenance instructions for the acquisition system which forms a part of the Mercury ground instrumentation at Point Arguello, California.

B. PROJECT MERCURY SCOPE

(1). The prime objective of Project Mercury is manned orbital flight with a safe return of the man from orbit. The manned vehicle or satellite that is placed into orbit is called the capsule, and the individual making the orbital flight is called the astronaut.

(2). A launch vehicle with a radio-inertial guidance system will be used to place the capsule into orbit. The launch will be from Cape Canaveral, Florida with launch azimuth slightly north of east (inclined 32.5 degrees to the equator) and nominal orbit insertion point approximately 410 nautical miles from Cape Canaveral. The planned orbit will have a period of 88 minutes and will be at an altitude of 105 ±5 nautical miles.

(3). Initially, the orbital flights will each consist of three orbital cycles with a water landing west of Puerto Rico. In the event of an in-flight emergency, backup systems are provided in the capsule to permit the flight to continue until the next passage over the eastern United States. Emergency landings at the completion of one orbit can be made in the Atlantic off of Charleston, South Carolina or near Bermuda. At the end of the second passage, the emergency landing area is in the Atlantic off of Charleston, South Carolina. If a malfunction occurs during the early launch phase, emergency procedures will permit a water landing off of Cape Canaveral. Controlled retro firing will be used to contain most of the abort impact areas near Bermuda or in the vicinity of the Canary Islands.

(4). To implement Project Mercury, a world-wide network of 18 ground-based tracking and instrumentation sites has been established together with a control center and a computing and communications center. Eleven of these sites are equipped with long range tracking radars; these compose the tracking network. Sixteen sites have telemetry receiving and display equipment. Six of the sites are equipped to transmit command control signals to the capsule; these are known as command sites. Sixteen of the sites are equipped with capsule communication equipment that provides two-way voice contact with the astronaut. In addition, all of the sites are linked with the computing and control centers by a ground communication network. See figure 1-1 for the locations of the sites.

C. SITE FUNCTIONS

From orbit insertion until landing, the tracking and ground instrumentation systems will provide continuous prediction of the capsule location, they will monitor the status of the capsule and astronaut, and they will permit the command functions necessary for the mission. The functions of the tracking and ground instrumentation systems are completed when the capsule has landed and the best possible information on the landing point location has been supplied to a recovery team. Table 1-I lists the various sites and the functions of each.

D. SYSTEM FUNCTIONS

The function of the acquisition system is to supply pointing data (capsule azimuth and elevation) to the radars, active acquisition aid, receiving antennas, and transmitting antenna. Pointing data is made available to the automatic-tracking radars and active acquisition aid for initial acquisition of the capsule and to aid them in quick reacquisition if they lose the capsule during a pass over the site. The other antennas on the site normally are pointed at all times during a pass by data from the acquisition system.

1-2. EQUIPMENT SUPPLIED

Table 1-II lists the equipment supplied for the acquisition system. A number of items of test equipment shown in this table are also used for other systems on the site. Such items are listed in the applicable manuals of the other systems as well as in this manual.

TABLE 1-I. FUNCTIONS OF EACH SITE

	S-Band Radar Tracking	C-Band Radar Tracking	Telemetry & Capsule Communications	Command Control
Cape Canaveral, Florida	X	X	X	X
Grand Bahama Island	-	-	X	-
Grand Turk Island	-	-	X	-
Bermuda	X	X	X	X
Atlantic Ship	-	-	X	-
Grand Canary Island	X	-	X	-
Kano, Nigeria	-	-	X	-
Zanzibar	-	-	X	-
Indian Ocean Ship	-	-	X	-
Muchea, Australia	X	-	X	X
Woomera, Australia	-	X	X	-
Canton Island	-	-	X	-
Kauai Island, Hawaii	X	X	X	X
Point Arguello, California	X	X	X	X
Guaymas, Mexico	X	-	X	X
White Sands, New Mexico	-	X	-	-
Corpus Christi, Texas	X	-	X	-
Eglin, Florida	X	X	-	-

1-3. DESCRIPTION OF ACQUISITION SYSTEM

A. GENERAL

The acquisition system at Point Arguello consists of the equipment listed in table 1-II. Each of the operating equipment units and systems is described in the following paragraphs.

B. PHYSICAL DESCRIPTION

(1). RADAR SITE ACQUISITION DATA CONSOLE (Figure 1-2)

The acquisition data console consists of a rack, 59-5/8 inches high, 23-9/16 inches wide and 22 inches deep, on which are mounted several panels. The acquisition data console is bolted to the active acquisition aid control console, as

TABLE 1-II. EQUIPMENT SUPPLIED

Equipment	Manufacturer	Model	Qty.	Instruction Book Inventory Number and Title
OPERATING EQUIPMENT				
Acquisition Data Console (Radar Site)	The Bendix Corporation Bendix Radio Division	R651499-1	1	MS-117, Acquisition System Manual - Operation and Maintenance-Point Arguello, California
Acquisition Data Console (Receiver Site)	The Bendix Corporation Bendix Radio Division	R651498-7	1	MS-117, Acquisition System Manual - Operation and Maintenance-Point Arguello, California
Active Acquisition Aid, consisting of:	Cubic Corporation		1	ME-129, Instruction Manual for Active Acquisition Aid (AGAVE)
Triplexer (Multiplexer)			1	
Diplexer (Multiplexer)			2	
RF Housing			1	
Amplidyne			2	
Receiver Cabinet			1	
Servo Cabinet			1	
Control Console			1	
Boresight Antenna and Transmitter			1	
Antenna and Pedestal consisting of:				
Quad helix array			1	
Ground plane			1	
Hybrid ring			4	
Pedestal			1	
Synchro Remoting Transmitter-Receiver (Transceiver)	The Bendix Corporation Bendix Pacific Division	1061778	4	ME-412, Instruction Manual for Digital Synchro Data Transmission System
Intercom Cabinet	The Bendix Corporation Bendix Radio Division	N651474-2	1	MS-109, Intrasite PBX and Intercom System Manual

TABLE 1-II. EQUIPMENT SUPPLIED (Cont.)

Equipment	Manufacturer	Model	Qty.	Instruction Book Inventory Number and Title
OPERATING EQUIPMENT (Cont.)				
Synchro Line Amplifier	Milgo Electronic Corporation	1007-10B	5	ME-132, Instruction Manual, Synchro Line Amplifier
Synchro Reference Step-up Transformer	The Bendix Corporation Bendix Radio Division	A665084-1	1	MS-117, Acquisition System Manual-Operation and Maintenance-Point Arguello, California
Synchro Reference Step-down Transformer	The Bendix Corporation Bendix Radio Division	A665085-1	2	MS-117, Acquisition System Manual-Operation and Maintenance-Point Arguello, California
Master-Slave Relay Panel	The Bendix Corporation Bendix Radio Division	653770-1	1	MS-117, Acquisition System Manual-Operation and Maintenance-Point Arguello, California
Antenna Drive Power Cutoff Switch and Warning Light	The Bendix Corporation Bendix Radio Division	L653858-1	1	MS-117, Acquisition System Manual-Operation and Maintenance-Point Arguello, California
TEST EQUIPMENT				
Oscilloscope	Hewlett-Packard Company	130B	1	ME-200, Operating and Servicing Manual, Model 130B/BR Oscilloscope
Oscilloscope	Tektronix, Incorporated	545A	3	ME-202, Instruction Manual, Type 535A Type 545A, Cathode Ray Oscilloscopes
Wide-Band, High-Gain Calibrated Preamp	Tektronix, Incorporated	Type B	1	ME-204, Instruction Manual Type B Plug-In Unit
Dual-Trace Calibrated Preamp	Tektronix, Incorporated	Type CA	3	ME-203, Instruction Manual Type CA Plug-In Unit
Plug-In Preamplifier	Tektronix, Incorporated	Type L	2	ME-136, Instruction Manual Type L Plug-In Unit

TABLE 1-II. EQUIPMENT SUPPLIED (Cont.)

Equipment	Manufacturer	Model	Qty.	Instruction Book Inventory Number and Title
TEST EQUIPMENT (Cont.)				
Viewing Hood	Tektronix, Incorporated	H510	3	ME-202, Instruction Manual, Type 535A, Type 545A, Cathode Ray Oscilloscopes (Accessories Section)
Oscilloscope Cart	Technibilt Corporation	OC-2 (Bendix Radio Part-A683940-2)	1	-
Oscilloscope Cart	Technibilt Corporation	OC-2 (Bendix Radio Part-A683940-1)	3	-
Unit Regulated Power Supply	General Radio Company	1201-B	1	ME-211, Operating Instructions, Type 1201-B Unit Regulated Power Supply
Regulated Power Supply	Lambda Electronics Corporation	71	1	ME-138, Instruction Manual, Lambda Regulated Power Supply Model 71
DC Power Supply	John Fluke Manufacturing Company, Incorporated	407	1	ME-231, Model 407 DC Power Supply, Instruction Manual
Square Wave Generator	Tektronix, Incorporated	Type 105	1	ME-230, Instruction Manual, Square Wave Generator Type 105
Signal Generator	Boonton Radio Corporation	225-A	3	ME-188, Instruction Manual for the Signal Generator Type 225-A
Sweep Generator	Telonic Industries, Incorporated	HN-3	1	ME-120, Operating Instruction Manual
HF Signal Generator	Hewlett-Packard Company	606-A	1	ME-189, Operating and Servicing Manual

TABLE 1-II. EQUIPMENT SUPPLIED (Cont.)

Equipment	Manufacturer	Model	Qty.	Instruction Book Inventory Number and Title
TEST EQUIPMENT (Cont.)				
Function Generator	Hewlett-Packard Company	202-A	1	ME-205, Operating and Servicing Manual
Transfer Oscillator	Hewlett-Packard Company	540-B	1	ME-232, Operating and Servicing Manual
Wide Range Oscillator	Hewlett-Packard Company	200 CD	2	ME-198, Operating and Servicing Manual
Unit Oscillator	General Radio Company	1209-BL	1	ME-212, Operating Instructions, Types 1209-B and BL Unit Oscillators
Universal EPUT and Timer	Beckman Instruments, Incorporated	7370	2	ME-196, Instruction Manual, Model 7370 Universal EPUT and Timer
Frequency Converter	Beckman Instruments, Incorporated	7570 through 7573	2	ME-197, Instruction Manual, Model 7570 Series Frequency Conversion Equipment
Field Strength Meter	Empire Devices Products Corporation	NF-105 (Bendix Part No. A683351)	2	ME-192, Instruction Manual for Noise and Field Intensity Meter
Power Output Meter	The Daven Company	OP-962	1	ME-154, Instruction Manual
Potentiometric DC Voltmeter	John Fluke Manufacturing Company, Incorporated	801	1	ME-118, Model 801 Potentiometric DC Voltmeter, Instruction Manual
Vacuum Tube Voltmeter	Hewlett-Packard Company	410B	3	ME-190, Operating and Servicing Manual
Vacuum Tube Voltmeter	Hewlett-Packard Company	400D	2	ME-191, 400D/H/L Vacuum Tube Voltmeter Operating and Servicing Manual
Volt-Ohm-Milliammeter	Triplett Electrical Instrument Company	630-PL	5	ME-193, Instruction Manual, Model 630-PL Volt-Ohm-Milliammeter

TABLE 1-II. EQUIPMENT SUPPLIED (Cont.)

Equipment	Manufacturer	Model	Qty.	Instruction Book Inventory Number and Title
TEST EQUIPMENT (Cont.)				
Noise and Distortion Analyzer	Hewlett-Packard Company	330B	1	ME-194, 330B/C/D Noise and Distortion Analyzer, Operating and Servicing Manual
RF Detector	Telonic Industires, Incorporated	XD-3	2	ME-135, Instruction Manual
Tube Analyzer	Triplett Electrical Instrument Company	3444	1	ME-199, Instruction Manual, Model 3444 Tube Analyzer
Variac	General Radio Company	W10MT	1	ME-246, Operating Instructions for W10 Variac
Miscellaneous Cables and Accessories	-	-	-	-

shown in figure 1-2. A common writing surface extends 18-1/2 inches from the front of both consoles. Omitting blanks and starting at the top, the panels of the acquisition data console are an intercom panel, an acquisition data panel, a synchro line amplifier (number 1), and a dual power supply. Ten intercom phone jacks, in two sets of five each, are mounted on the front of the writing surface. Two relay chassis are mounted in the console, one on the left side and one on the right side. Both of these chassis are near the acquisition data panel. Approximately in the center of the back of the console is mounted a synchro reference voltage step-down transformer. Also in the back of the console there is a second synchro line amplifier (number 2). For information on the intercom panel, which is not functionally part of the acquisition data console, refer to the Intrasite PBX and Intercom System Manual, MS-109. For a description of the synchro line amplifiers, refer to paragraph 1-3.B.(4).

(a). ACQUISITION DATA PANEL

The acquisition data panel is made up of displays, indicators and controls.

1. Across the top of the panel there are four pairs of synchro receivers which display azimuth and elevation data from the active acquisition aid, the Verlort radar, the FPS-16 radar and the remote (receiver) site. There also is a pair of lamps ("CABLE WRAP") which indicates the azimuth position of the active acquisition aid relative to the limits of cable wrap.

2. Just below the synchro receivers there is a row of indicator and switch assemblies, henceforth called simply indicators and switches. The indicators consist of a set of lamps, color filters over the lamps, and a white, translucent screen on the front of the assembly. The switches are like the indicators with the addition of a multi-pole switch and a coil which when energized holds the switch contacts in their actuated position. The switch is initially actuated by depressing the screen. The screens of both the indicators and switches always appear white when the lamps are not lit. When the lamps are lit, the screens appear red, yellow or green, depending on the color of the filters in the particular assembly.

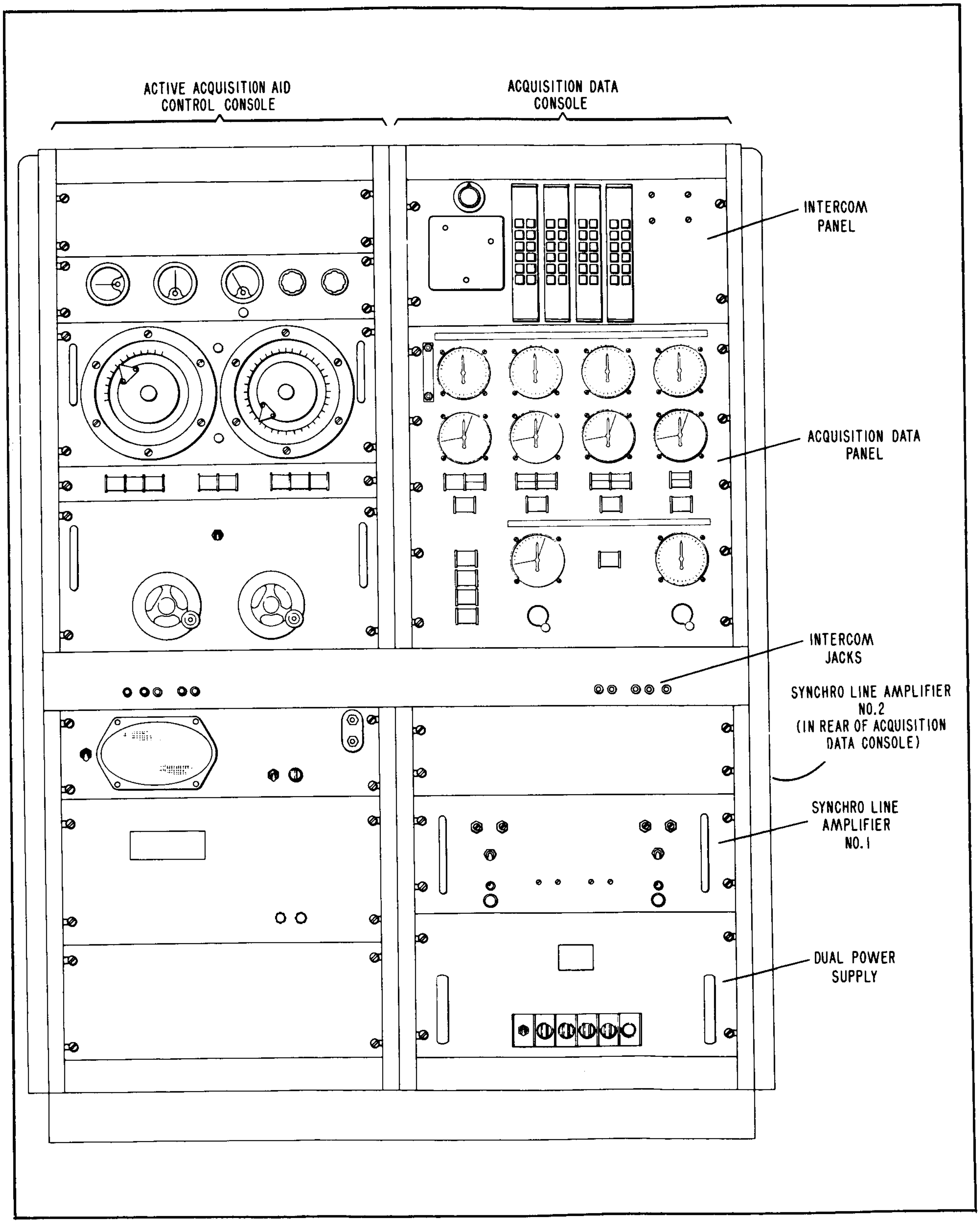


Figure 1-2. Acquisition Data Console and Active Acquisition Aid Control Console, Radar Site

3. On the left, below the active acquisition aid synchro receivers, are two indicators and one switch. One of the indicators is labeled "AUTO" (yellow when lit). The other is a double indicator; the top half is labeled "SLAVED" (green when lit), and the bottom half "MANUAL" (red when lit). The switch is labeled "SOURCE" (yellow when lit).

4. Two more indicators and a switch are below the Verlort radar synchro receivers. One of the indicators is labeled "VALID TRACK" (yellow when lit). The other is a double indicator; the top half is labeled "SLAVED" (green when lit), and the bottom half "MANUAL" (red when lit). The switch is labeled "SOURCE" (yellow when lit).

5. Beneath the FPS-16 radar synchro receivers are two indicators and a switch which has the same labels and colors when lit as the corresponding indicators and switch associated with the Verlort radar.

6. On the right, below the remote (receiver) site synchro receivers, there is a double indicator and a switch. The top half of the indicator is labeled "SLAVED" (green when lit), and the bottom half is labeled "MANUAL" (red when lit). The switch is labeled "SOURCE" (yellow when lit).

7. In the lower left-hand corner of the panel there are two switches and two indicators. One of the indicators is labeled "DATA LINK POWER" (green when lit), and the other is labeled "NO DATA ON BUS" (red when lit). Both of the switches are labeled "28 V SUPPLY". They are either red or green when lit.

8. In the bottom center and bottom right-hand corner of the panel there is a pair of synchro transmitter-synchro receiver combinations, one for manual elevation settings and one for manual azimuth settings. The synchro transmitters are turned by handwheels on the front of the panel; the synchro receivers indicate the angular position of the transmitter rotors. Between

the two receivers there is a switch labeled "SOURCE" (yellow when lit).

(b). DUAL POWER SUPPLY

Four power supply chassis together with one of the relay chassis described below make up two, 28 VDC power supplies. Each power supply has a transformer, a silicon bridge rectifier, a fuse, and two filter capacitors on one chassis, and a filter choke and three filter capacitors on a second chassis. The dual power supply panel provides mounting for these four chassis. On the front of the panel are an off-on switch, which controls the primary power to both power supplies; a power-on indicator ; and four line fuses—two for each power supply—in indicating-type fuse holders.

(c). RELAY CHASSIS

The relay chassis on the right side of the console provides mounting for four diodes and two relays which make up the control circuits for the 28 VDC power supplies in the console. The same chassis also provides mounting for three relays which when energized connect acquisition data from different sources to the acquisition bus. The relay chassis on the right side of the console rack provides mounting for two relays which protect synchros from damage in the event that reference voltage is turned off in the console while it is still applied to either of the site radars.

(2). RECEIVER SITE ACQUISITION DATA CONSOLE (Figure 1-3)

The receiver site acquisition data console consists of a rack, 59-5/8 inches high, 23-9/16 inches wide and 22 inches deep, on which are mounted several panels. A writing surface extends 18-1/2 inches from the front of the console. Starting at the top, the panels of the console are a signal strength meter panel, an acquisition data panel, an audio amplifier, a synchro line amplifier and a dual power supply. Five intercom phone jacks are mounted on the front of the writing surface. One relay chassis is mounted on the right side of the console and another on the left side. For a description of the synchro line amplifier, refer to paragraph 1-3.B.(4).

(a). ACQUISITION DATA PANEL

Like the radar site console acquisition data panel, the acquisition data

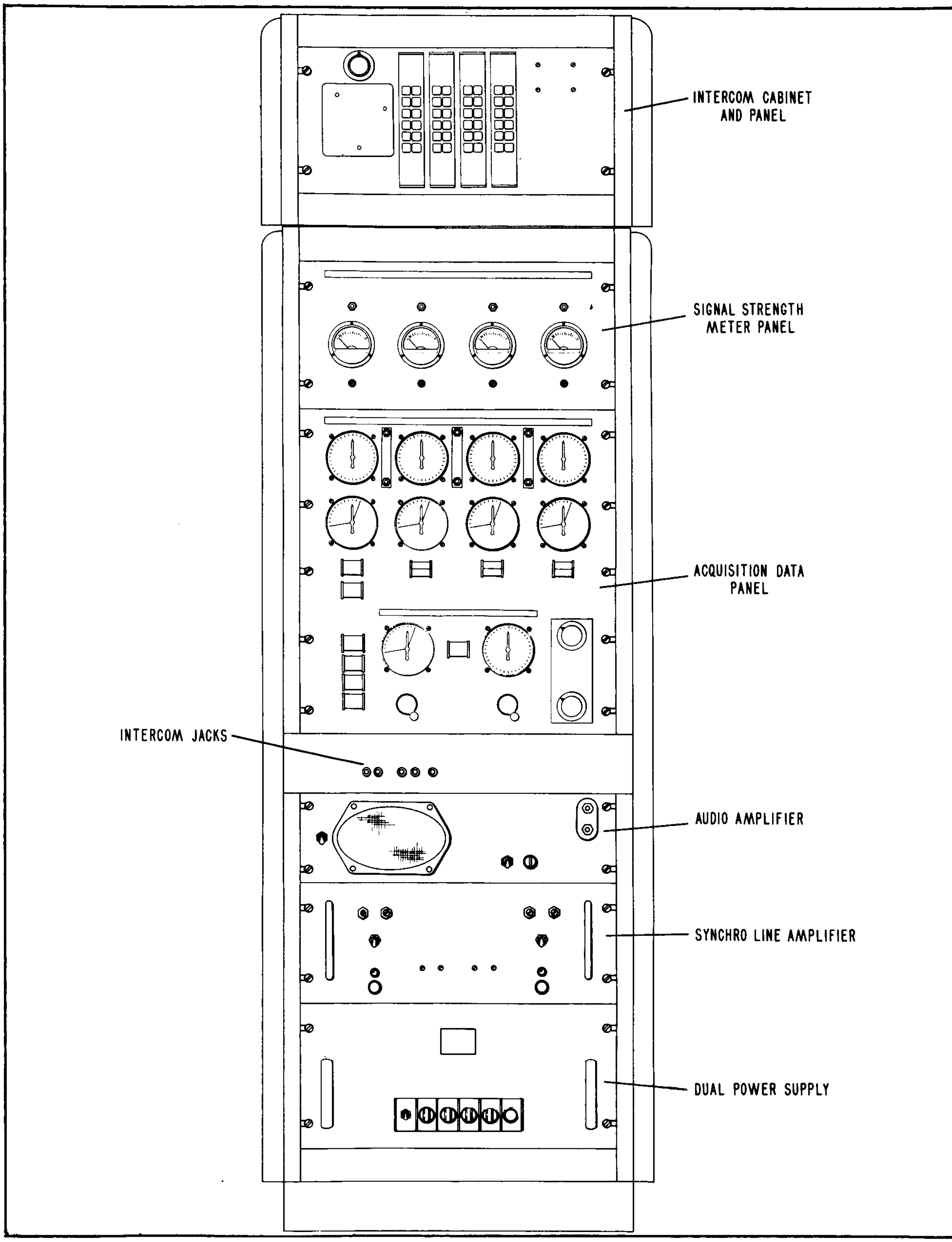


Figure 1-3. Acquisition Data Console and Intercom Cabinet, Receiver Site

panel on the receiver site console is made up of displays, indicators and controls.

1. Across the top of the panel there are four pairs of synchro receivers which display azimuth and elevation data from the radar site, the transmitting antenna, receiving antenna number 1, and receiving antenna number 2. There also are three pairs of lamps ("CABLE WRAP") which indicate the azimuth position of the transmitting and receiving antennas relative to the limits of cable wrap.

2. Just below the synchro receivers there is a row of indicator and switch assemblies of the same type as those on the radar site console. [Refer to paragraph 1-3.B.(1).(a).] On the left, below the radar site synchro receivers, are one indicator and one switch. The indicator is labeled "NO DATA ON BUS" (red when lit), and the switch is labeled "SOURCE" (yellow when lit).

3. Beneath the transmitting and receiving antenna synchro receivers there are three identical double indicators, one beneath each of the synchro displays. The top half of these indicators is labeled "SLAVED" (green when lit) and the bottom half "MANUAL" (red when lit).

4. In the lower left-hand corner of the panel there are two switches and two indicators. The indicators are labeled "DATA LINK POWER NO. 1" and "DATA LINK POWER NO. 2". Both are green when lit. The switches are labeled "28 V SUPPLY". They are either red or green when lit.

5. In the bottom center of the panel there is a pair of synchro transmitter-synchro receiver combinations and a source switch for manual input display and control. These displays and controls are the same as the corresponding displays and controls on the radar site console. [Refer to paragraph 1-3.B.(1).(a).]

6. In the lower right-hand corner of the panel there is a telemetry audio channel selector switch and volume control.

(b). DUAL POWER SUPPLY

The dual power supply in the receiver site acquisition data console is identical to that in the radar site console. Refer to paragraph 1-3.B.(1).(b).

(c). SIGNAL STRENGTH METER PANEL

The signal strength meter panel consists of four meters, four pilot lamps and four calibration controls for the meters.

(d). AUDIO AMPLIFIER

The audio amplifier consists primarily of a power supply, two vacuum tube voltage amplifier stages, and an output stage. On the front panel of the amplifier there is a speaker, a speaker off-on switch, a power off-on switch, a fuse, and a pair of phone jacks. This amplifier is identical to the one in the active acquisition aid control console (at the radar site).

(e). RELAY CHASSIS

The relay chassis on the right side of the console provides mounting for two relays and four diodes which make up control circuitry for the 28 VDC power supplies. This chassis also provides mounting for two relays which when energized connect acquisition data from different sources to the acquisition bus. The relay chassis on the left side of the console provides mounting for four relays which control the d-c indications from the transmitting antenna.

(3). INTERCOM CABINET (Figure 1-3)

The intercom cabinet, which sits on top of the receiver site acquisition data console as shown in figure 1-3, houses the intercom panel. The intercom equipment is not part of the acquisition system as such; for information on it, refer to the Intrasite PBX and Intercom System Manual, MS-109.

(4). SYNCHRO LINE AMPLIFIERS

The synchro line amplifiers are mounted on 7-inch by 19-inch panels. Each line amplifier consists of two pairs of amplifier units. Each pair of amplifier units makes up an amplifier channel; thus, a synchro line amplifier has two channels, one for azimuth information and the other for elevation information. On the front of the panel of each line amplifier there are two identical sets of controls. Each set consists of two line compensation controls, an off-on switch, a power-on indicator lamp, and a fuse. On the back of the panel there are two individual chassis, each of which contains two amplifier units (one amplifier channel) and a power supply. For a complete physical description of the synchro line amplifiers, refer to the applicable equipment manual, listed in table 1-II.

(5). ACTIVE ACQUISITION AID (Figures 1-2 through 1-10)

The active acquisition aid, which is a system in itself, comprises eleven major units or assemblies; a control console, a receiver cabinet, a servo cabinet, an antenna and pedestal, two amplidynes, two diplexers, a triplexer, an RF housing, and a boresight antenna and transmitter.

(a). The active acquisition aid control console (shown along with the radar site acquisition data console in figure 1-2) has the same overall dimensions as the acquisition data console, to which it is bolted. As does the acquisition data console, the active acquisition aid control console consists of a rack in which are mounted a number of panels. The controls, indicators, and switches for the operation of the active acquisition aid are on these panels.

(b). The receiver cabinet contains the circuits of the active acquisition aid which develop the error signals used to position the antenna for tracking. The receiver cabinet is 23-9/16 inches wide, 22 inches deep and 77 inches high. It is bolted to the servo cabinet. (See figure 1-4.)

(c). The servo cabinet (figure 1-4) houses components of the servo system which positions the antenna in azimuth and elevation. Its overall physical dimensions are the same as those of the receiver cabinet, to which it is bolted.

(d). The active acquisition aid antenna and pedestal (figure 1-5) includes a quad-helix array, a ground plane, four hybrid rings, and the pedestal itself.

(e). For physical descriptions of the amplidynes, diplexers, triplexer, RF housing, and boresight antenna and transmitter (figures 1-6 through 1-10) and for complete physical descriptions of the control

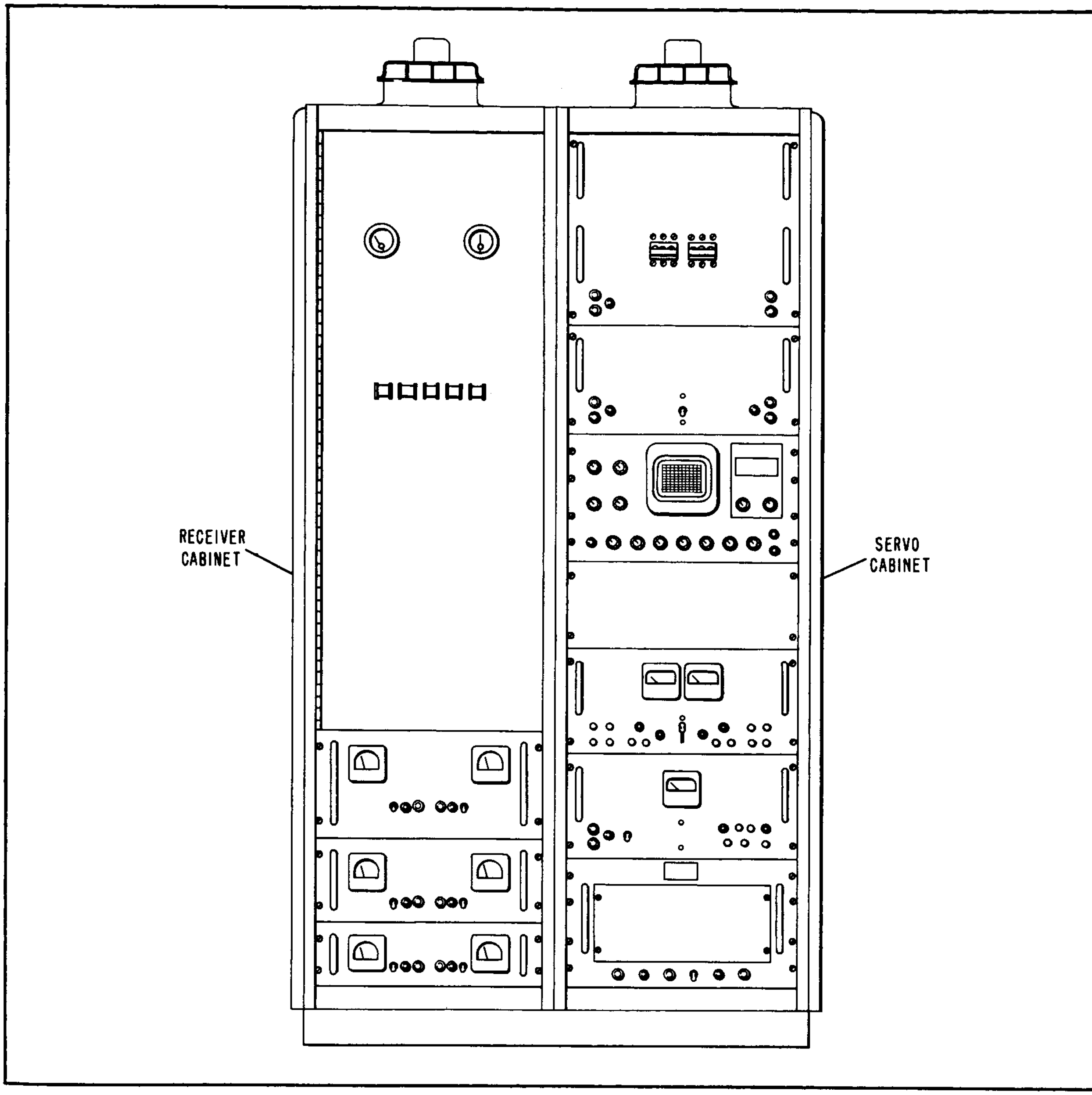


Figure 1-4. Active Acquisition Aid Receiver Cabinet and Servo Cabinet

console, receiver cabinet, servo cabinet, and antenna and pedestal, refer to the applicable equipment manual.

(6). SYNCHRO REMOTING SYSTEM

Synchro remoting system equipment at Point Arguello consists of four identical transmitter-receiver units (transceivers) which are in cabinets 68-3/8 inches high, 23-9/16 inches wide, and 23 inches deep (figure 1-11). Each unit consists of two

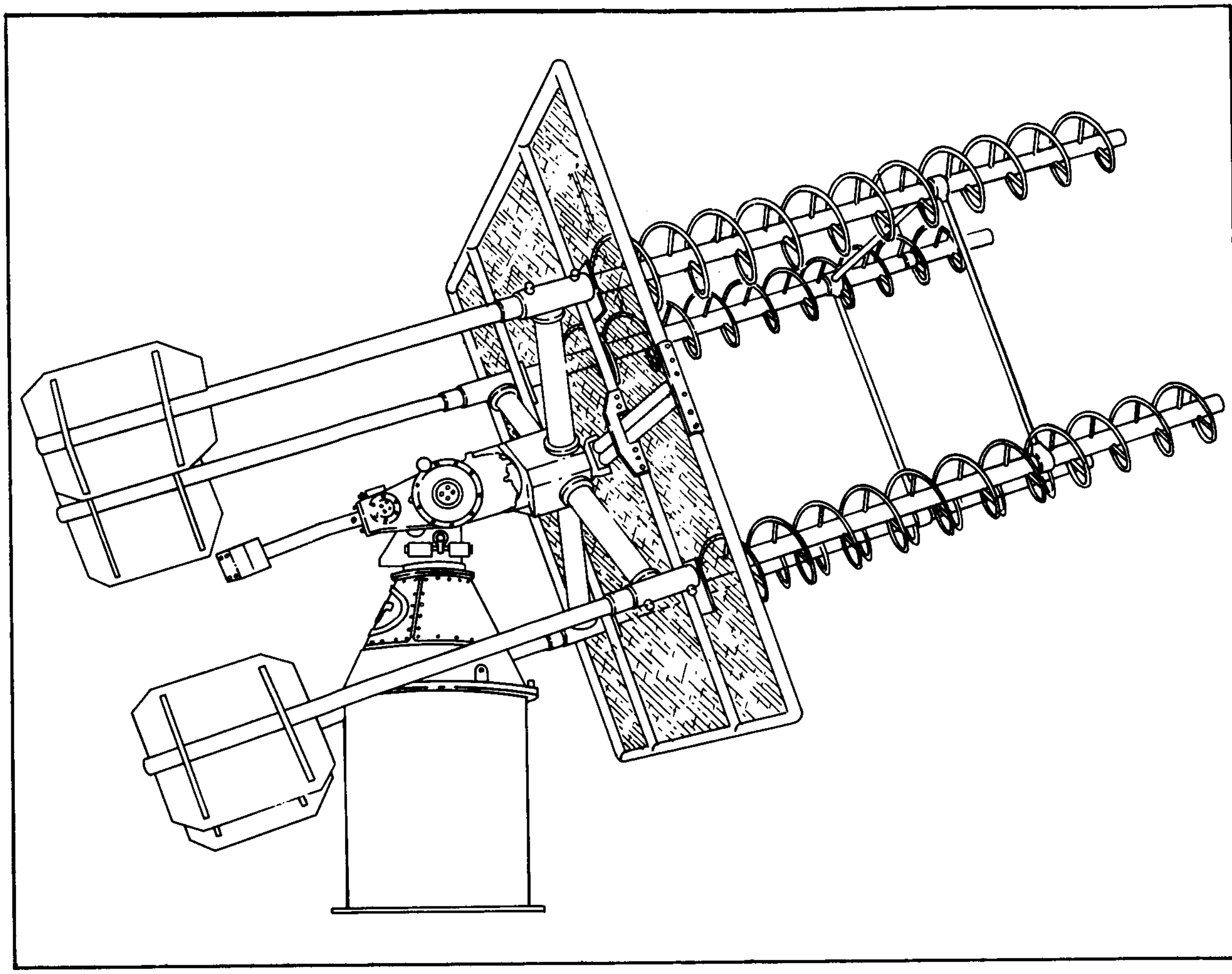


Figure 1-5. Active Acquisition Aid Antenna and Pedestal

transmitter channels and two receiver channels, one transmitter and one receiver channel for azimuth information and one transmitter and one receiver channel for elevation information. A pair of transmitter-receivers thus provides two-way transmission and reception of both azimuth and elevation synchro information. For a complete physical description of the units of the synchro remoting system, refer to the applicable equipment manual.

(7). ADDITIONAL EQUIPMENT

(a). SYNCHRO REFERENCE VOLTAGE TRANSFORMERS

The synchro reference voltage step-up transformer is shown in figure 1-12. Its dimensions are 12-1/2 inches by 13 inches by 15 inches, and its weight is 150 pounds. A synchro reference voltage step-down

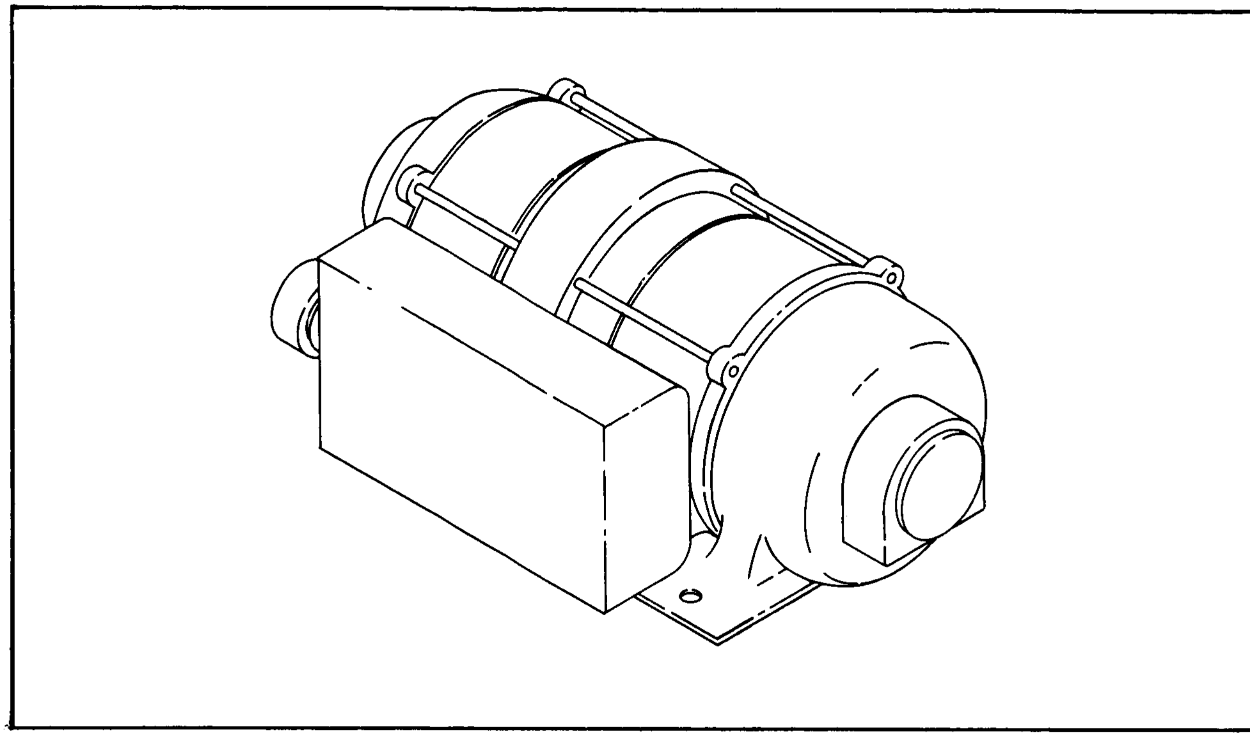


Figure 1-6. Active Acquisition Aid Amplidyne

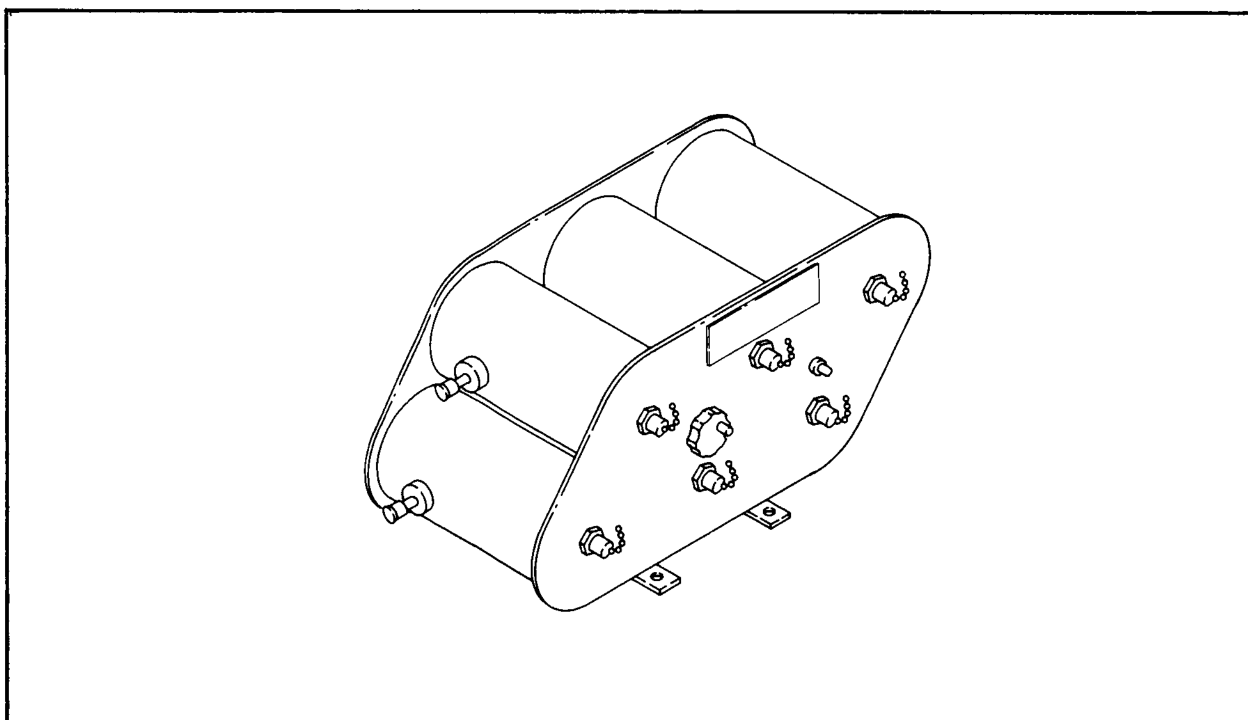


Figure 1-7. Active Acquisition Aid Diplexer (Multiplexer)

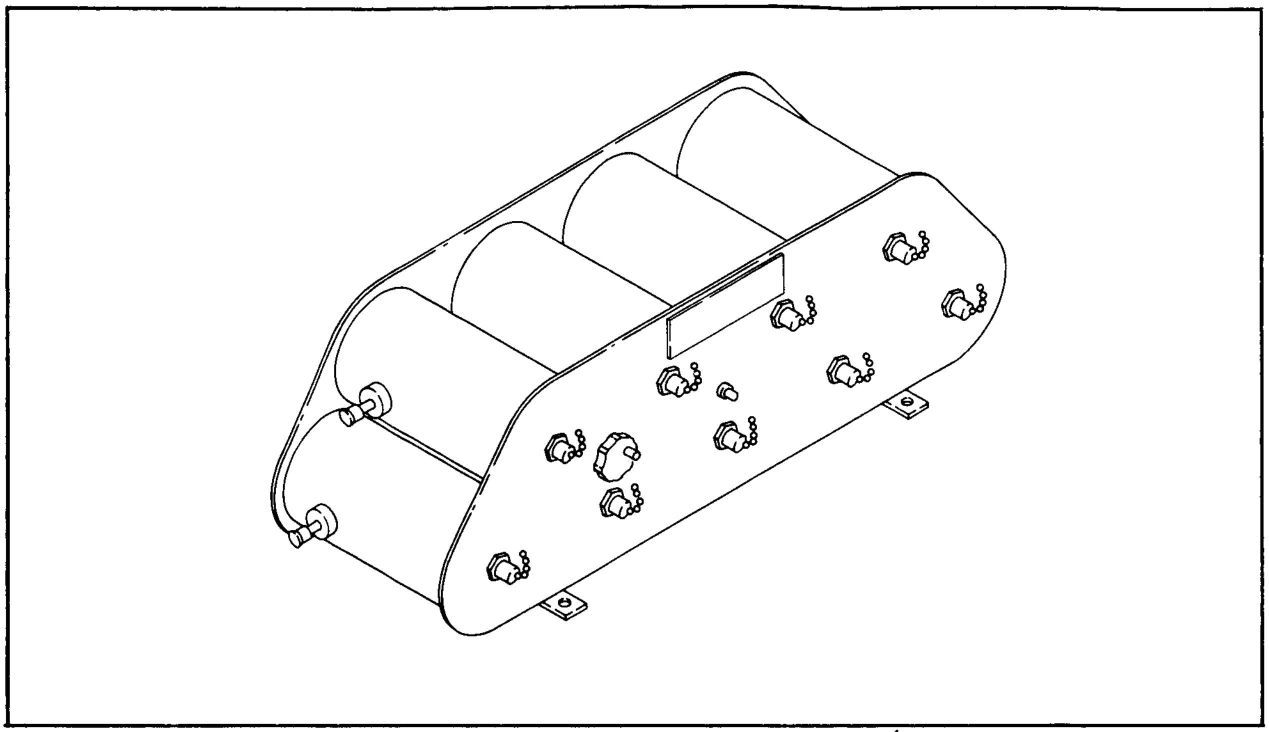


Figure 1-8. Active Acquisition Aid Triplexer (Multiplexer)

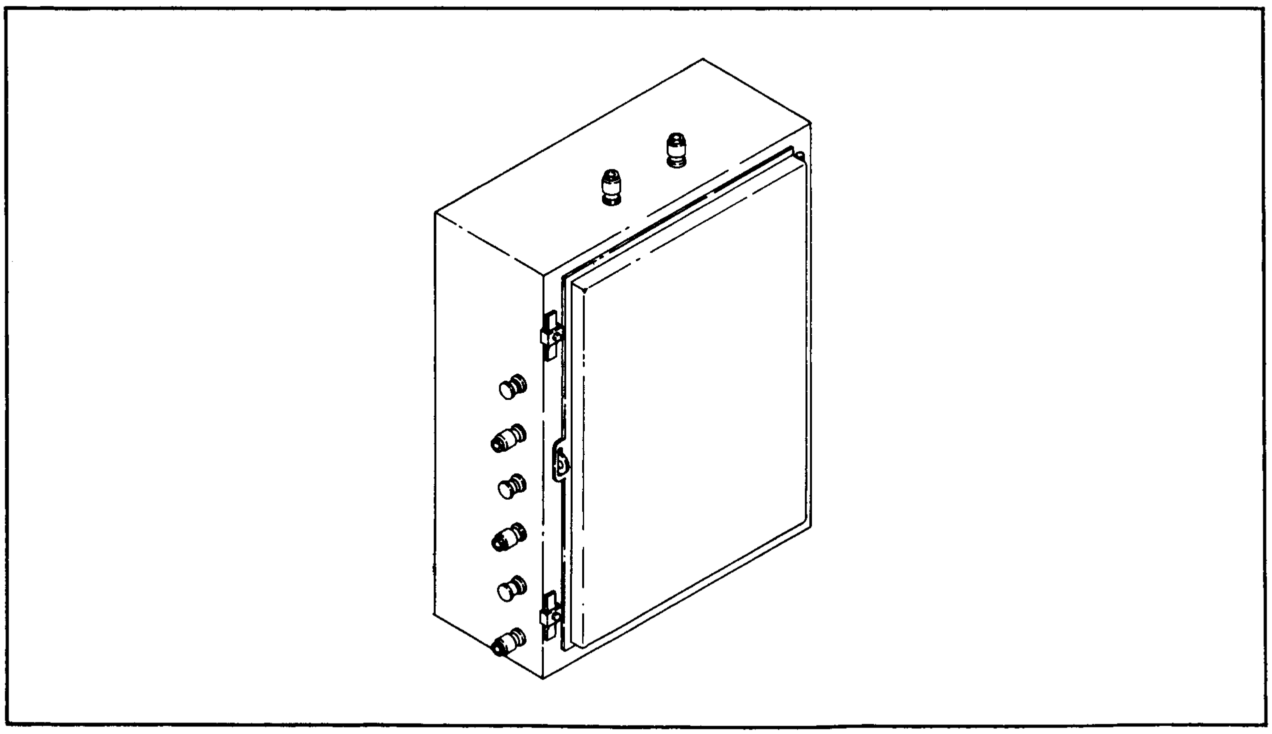


Figure 1-9. Active Acquisition Aid RF Housing

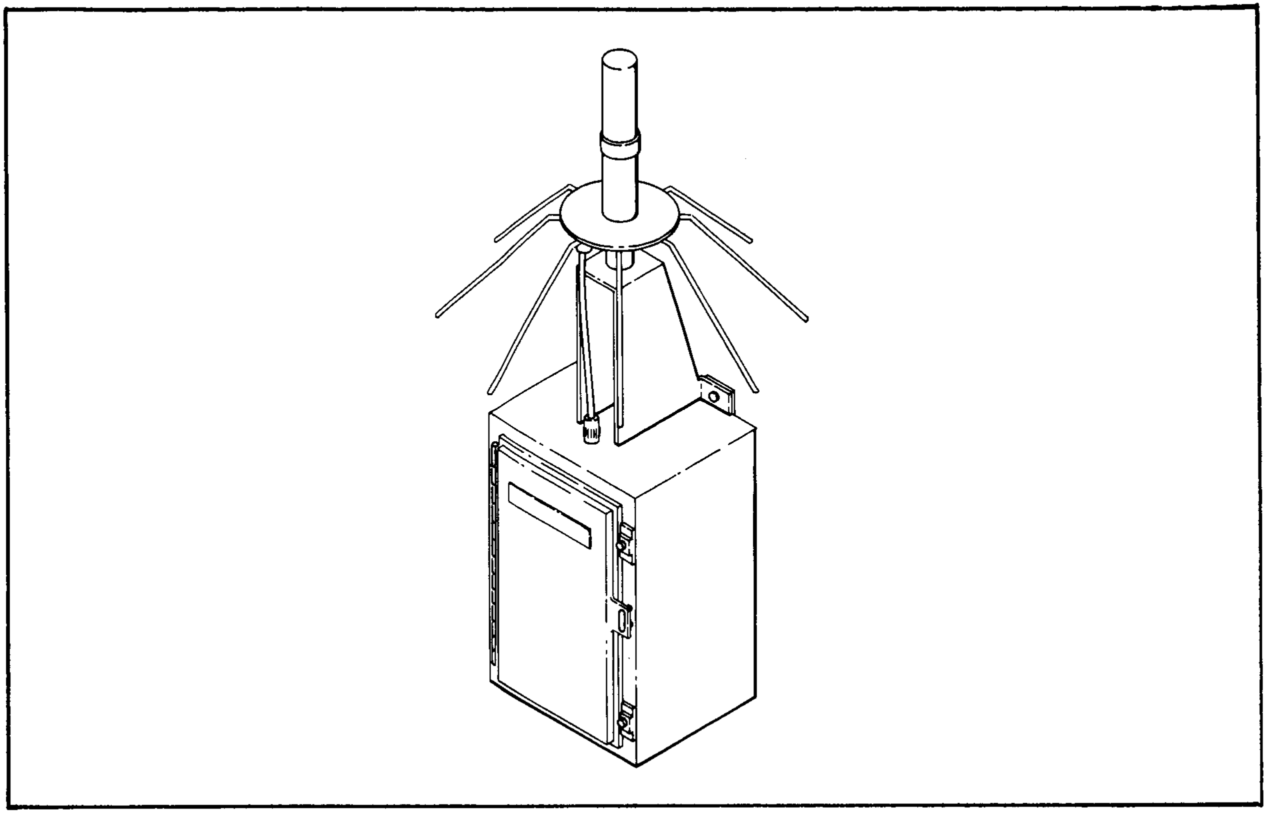


Figure 1-10. Active Acquisition Aid Boresight Antenna and Transmitter

transformer also is shown in figure 1-12. Its dimensions are 7-5/8 inches by 7-5/8 inches by 7-1/2 inches, and its weight is 35 pounds.

(b). MASTER-SLAVE RELAY PANEL

The master-slave relay panel, shown in figure 1-13, consists of a control relay and two terminal boards.

(c). FPS-16 RADAR CONTROL RELAY

The FPS-16 radar control relay is relay K9011 in the FPS-16 radar data switch unit. Refer to the Radar Tracking System Manual, MS-101 for information on the data switch unit.

(d). ANTENNA DRIVE POWER CUTOFF SWITCH AND WARNING LIGHT

The antenna drive power cutoff switch and warning light (figure 1-14) contains a double-pole, single-throw switch and a red warning light mounted on a 6-inch by 12-3/4-inch frame.

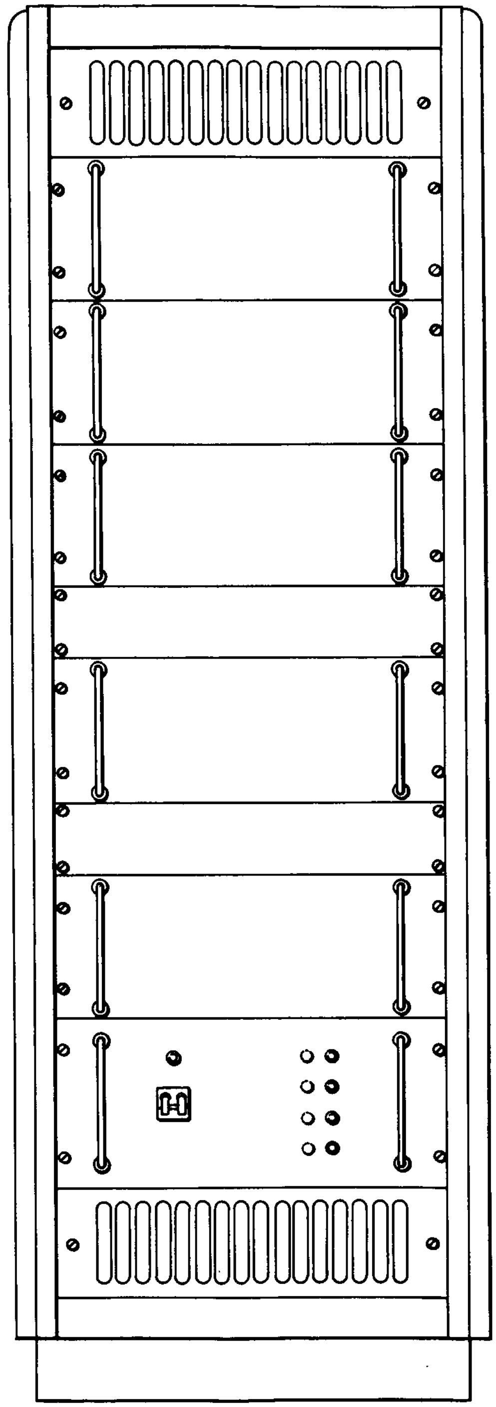


Figure 1-11. Synchro Remoting System Transmitter-Receiver

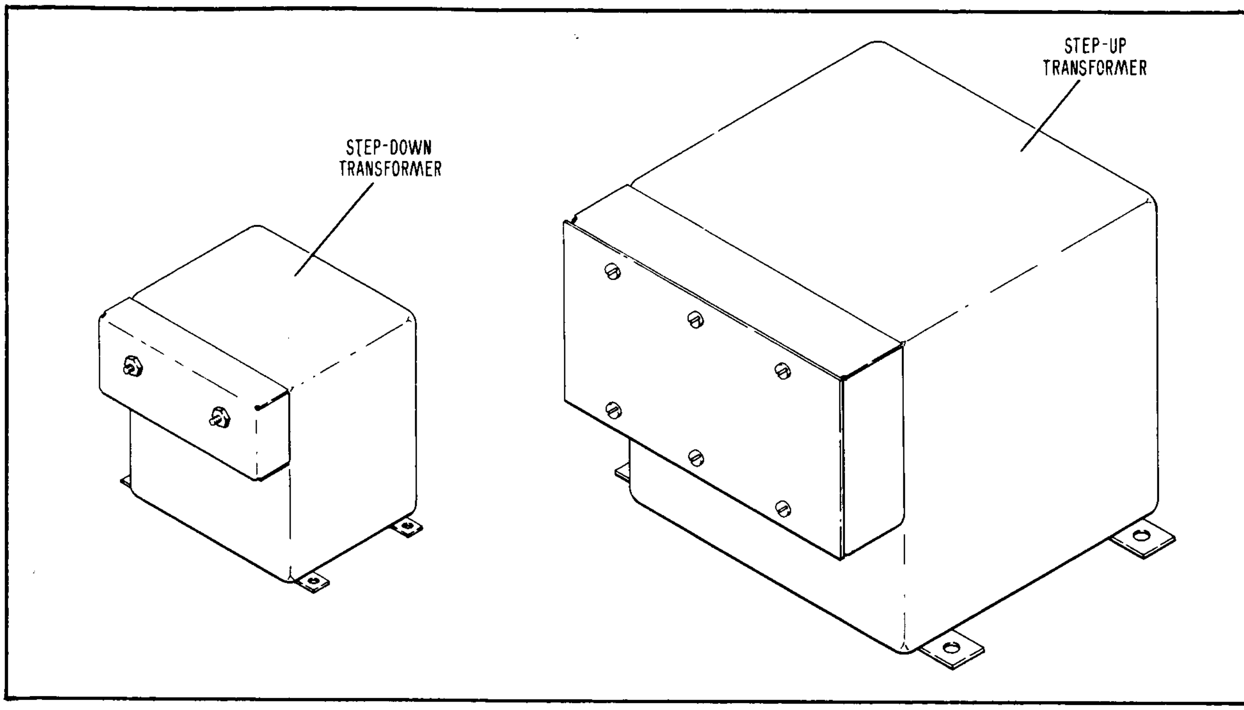


Figure 1-12. Synchro Reference Voltage Step-up and Step-down Transformers

C. FUNCTIONAL DESCRIPTION

(1). GENERAL

(a). Acquisition system equipment at Point Arguello is in three locations: the radar site, the receiver site, and the transmitter site. The three groups of equipment are provided with interconnecting circuits (synchro remoting systems) and normally are operated as a single system. In the case of emergency, however, or under other unusual circumstances the three sites may be operated with varying degrees of independence. The equipment at the radar site consists primarily of an acquisition data console, an active acquisition aid, and a synchro remoting system unit. At the receiver site the primary equipment is an acquisition data console and synchro remoting system unit. At the transmitter site it is just a synchro remoting system unit.

(b). The function of the acquisition system is to supply the best (most accurate) data available on the azimuth and elevation of the

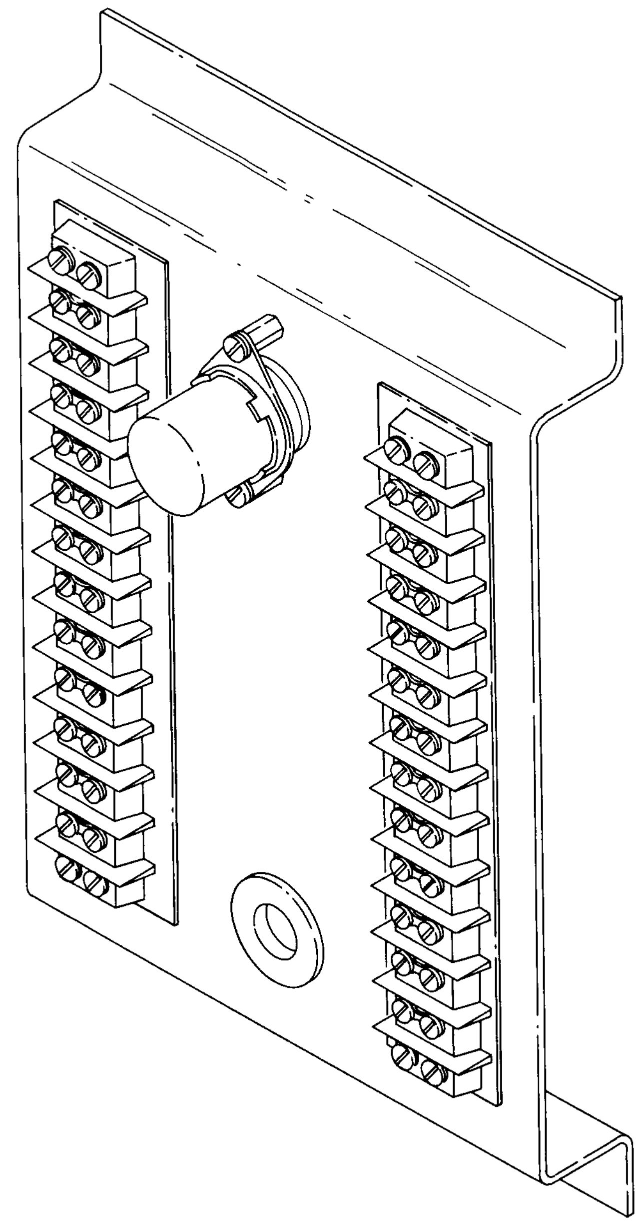


Figure 1-13. Master-Slave Relay Panel

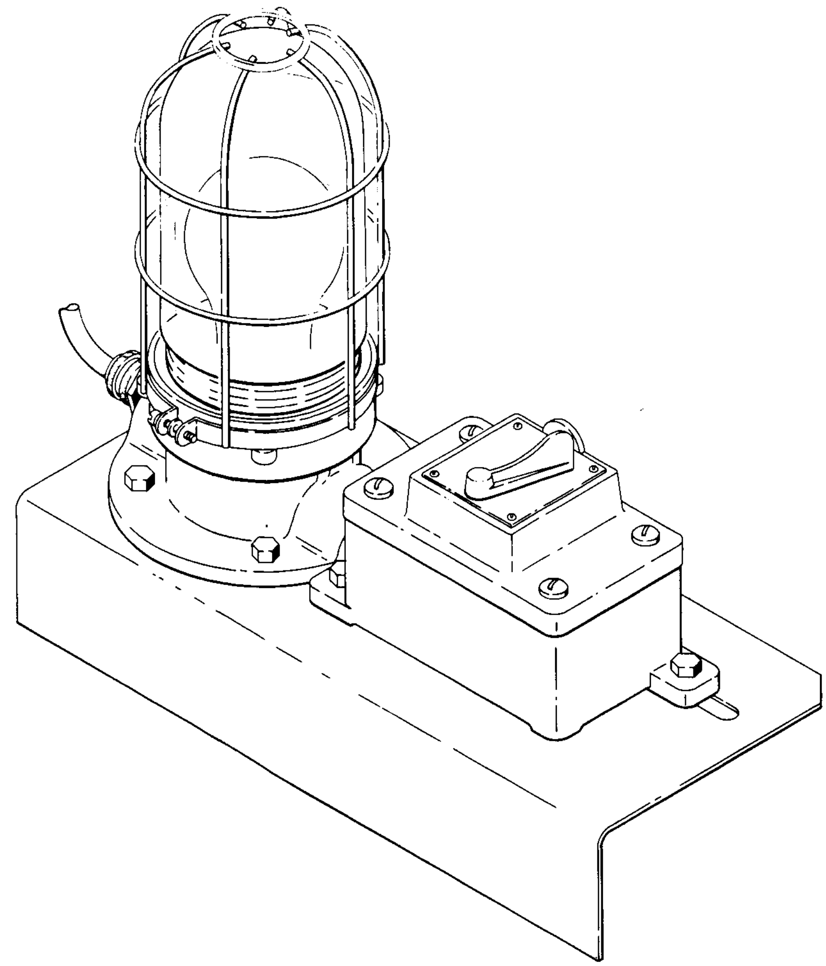


Figure 1-14. Antenna Drive Power Cutoff Switch and Warning Light

Mercury capsule to the steerable antennas on the site. Figure 1-15 illustrates this function. When no actual tracking information is available, predicted azimuth and elevation of the capsule at a given time are put onto the acquisition bus at the radar site by the settings of synchro transmitters on the acquisition data console. The settings of these synchro transmitters are the manual input shown on figure 1-15 at the radar site. The manual input at the receiver site is used only when data from the radar site is unavailable. The information manually set into the radar site acquisition data console is then available to the FPS-16 radar, the Verlort radar and the active acquisition aid at the radar site, to receiving antennas numbers 1 and 2 at the receiver site, and to the transmitting antenna and PMR van at the transmitter site. Once the active acquisition aid has acquired the capsule and is tracking it automatically or manually, its information on capsule azimuth and elevation is available for putting on the acquisition bus for use by all of the other steerable antennas on the site. It is possible that one of the radars on the site will acquire the capsule before the active acquisition aid. In this event, data from the tracking radar will be put onto the acquisition bus.

(c). Figure 1-16 is a simplified block diagram of the acquisition system. The acquisition bus, which distributes the two channel (azimuth and elevation) of acquisition data, is illustrated by heavy lines. At the radar site, data from one of five sources is put onto the acquisition bus by the data source selector, which in actuality consists of several switches and relays on the acquisition data console. The five sources are the manual input, the active acquisition aid, the Verlort radar, the FPS-16 radar, and emergency slaving data from receiving antenna number 1 at the receiver site. Except when one of the radars is the source, data on the bus goes from the acquisition data console directly to the FPS-16 radar, through synchro line amplifier number 3 to the Verlort radar, and through synchro line amplifier number 2 to the active acquisition aid and to one of the transmitter-receiver units of synchro remoting system number 2 for transmission to the receiver and transmitter sites. When one of the radars is the selected source of data, the data does not go through the acquisition data console, but is switched directly onto the acquisition bus by the associated radar control relay (which is energized by the data source selector on the console). Manual data is available for switching onto the acquisition bus whenever the synchro transmitters on the acquisition data console have the necessary information set into them. Data from the radars is available for switching onto the bus whenever they are tracking automatically. Data from the active acquisition aid can be switched onto the bus whenever it is tracking automatically or manually. Data from the receiver site can be used at the transmitter

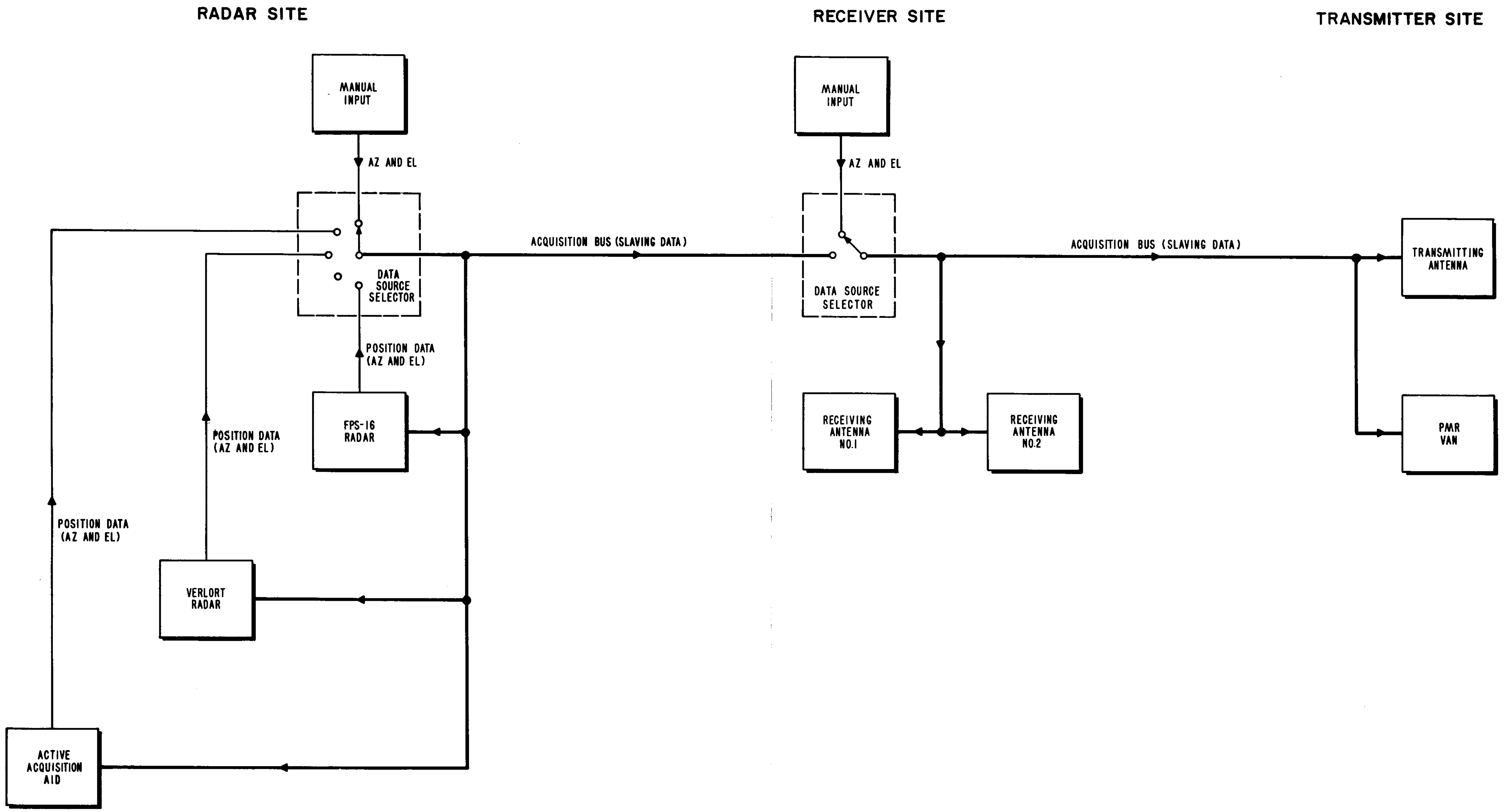


Figure 1-15. Basic Functions of the Acquisition System

site whenever one of the receiving antennas is being manually positioned in accordance with telemetry signal strength indications. In addition to the position data from the active acquisition aid and the radars and emergency slaving data from the receiver site, operating mode information from the receiver site and display data and operating mode information from the active acquisition aid and the radars are supplied to the radar site acquisition data console. The paths of the display data and the operating mode information are not shown on figure 1-16.

(d). At the receiver site, data from one of two sources, manual input or the radar site, is put onto the bus by the data source selector on the acquisition data console. (Data from the radar site is the source normally selected.) Data from the radar site comes to the receiver site acquisition data console through synchro remoting system number 2. From the receiver site acquisition data console, data on the bus goes through the receiver site synchro line amplifier to receiving antennas numbers 1 and 2 and to a transmitter-receiver of synchro remoting system number 1 for transmission to the transmitter site. Display data and operating mode information from the receiving antennas and from the transmitting antenna are supplied to the receiver site acquisition data console. This data and information is not shown on figure 1-16. Emergency slaving data (actually display data) from receiving antenna number 1 is supplied from the antenna through the acquisition data console to synchro remoting system number 2 for transmission to the radar site.

(e). The acquisition bus is connected to equipment at the transmitter site through synchro remoting system number 1. From the synchro remoting transmitter-receiver at the transmitter site, the bus goes through a synchro line amplifier to the transmitting antenna and the PMR van, which has a steerable antenna associated with it. Display data from the transmitting antennas, not shown on figure 1-16, is supplied from the transmitting antenna through synchro remoting system number 1 to the receiver site acquisition data console. There is no display data or operating mode information from the PMR van.

(2). RADAR SITE ACQUISITION DATA CONSOLE

The acquisition data consoles are the control centers of the acquisition system. The radar site console contains indicator lights, synchro displays (receivers), and control switches and relays. It also contains synchro transmitters for putting predicted acquisition data into the system. The inputs to the console, other than primary power, are operating mode information in d-c form, synchro position data, and synchro display data. The operating mode information is used simply to light lamps which indicate the operating mode of the steerable antennas: for instance, automatic tracking, manual tracking, or slaved. Synchro position data is put on the acquisition bus for slaving the active acquisition aid, the Verlort radar, the FPS-16 radar, and the antennas at the receiver and transmitter sites. Synchro display data is displayed by means of synchro receivers on the console. This data is used only for monitoring purposes; it is not put on the acquisition bus for slaving purposes. (One exception to this arrangement is the emergency slaving data from receiving antenna number 1. It is actually display data which also can be switched onto the radar site acquisition bus.) The functions of the various indicators, displays and controls on the console are described in the following paragraphs; a simplified schematic is shown in figure 1-17.

(a). The d-c indications coming into the console from the Verlort radar are "VALID TRACK", "SLAVED", and "MANUAL". These indications show whether the radar is tracking the capsule automatically, is being operated manually, or is slaved to the data on the acquisition bus. The only synchro data coming into the acquisition data console from the Verlort radar is azimuth and elevation display (each of the synchro symbols on figure 1-17 represents a pair of synchros, one for azimuth data and one for elevation data). It comes in through synchro line amplifier number 1. The mode indications and the synchro displays allow the acquisition data console operator to monitor the operation of the radar antenna insofar as its positioning in azimuth and elevation is concerned. Verlort radar position data does not come into the console at any time, but is put onto the acquisition bus by a relay in the radar which is controlled by a switch on the console. This switch and the path of the d-c control for the radar relay are shown in simplified form on figure 1-17.

(b). The d-c indications and synchro display from the FPS-16 coming into the console are the same as those from the Verlort radar, described in the previous paragraph, except the FPS-16 synchro display data does not go through a synchro line amplifier. FPS-16 synchro position data is controlled from the console in the same manner as the Verlort position data.

(c). From the receiver site acquisition data console there are two d-c indications coming into the radar site console. These are "MANUAL" and "SLAVED". These show whether data on the acquisition bus at the receiver and transmitter sites is from the manual input at the receiver site acquisition data console and is therefore independent of the radar site bus, or whether the receiver and transmitter site bus is connected to the radar site bus. The synchro information from the receiver site is azimuth and elevation position data (emergency slaving data) which can be switched onto the acquisition bus. (Actually, this data is display data from receiving antenna number 1. In an emergency it can be used as position data at the radar site.) The same data is displayed by a pair of synchro receivers on the acquisition data console.

(d). The d-c indications coming into the acquisition data console from the active acquisition aid are "AUTO", "SLAVED", and "MANUAL" mode indications and a "CABLE WRAP" indication. The mode indications show whether the active acquisition aid is tracking the capsule automatically, is being operated manually, or is slaved to the data on the acquisition bus. The cable wrap indication permits the acquisition data console operator to determine the azimuth position of the active acquisition aid antenna relative to its cable wrap limits. (The rotation of the antenna is restricted to 540 degrees because of cabling which wraps around the pedestal as it turns.) Two separate sets of synchro information come into the console from the active acquisition aid; these are display data and position data. The display data is displayed on a pair of synchros on the console. The position data, which comes from a separate pair of synchro transmitters on the active acquisition aid, is available for switching onto the acquisition bus.

(e). A power-on d-c indication comes into the console from the radar site transmitter-receiver unit of synchro remoting system number 2.

(f). Data from the manual input synchro transmitters on the console is displayed by a pair of synchro receivers and is available for switching onto the acquisition bus.

(g). Position data from the radars, the active acquisition aid, the manual input, or the receiver site is put onto the acquisition bus by means of switches and relays. These switches and relays are shown on figure 1-17 simply as switches beneath the manual, active acquisition aid, radar, and receiver site displays. These controls, which make up the "data source selector" shown on figures 1-15 and 1-16, are electrically interlocked with a sixth, the switch in series with the "NO DATA ON BUS" indicator. Thus, data from only one source can be on the acquisition bus at any one time; and when there is no data on the bus, the "NO DATA ON BUS" indicator is lit. "SOURCE" indicators associated with the data selector switches show the source of whatever data has been switched onto the acquisition bus.

(h). There are two 28 VDC power supplies on the acquisition data console, either one of which is capable of supplying all of the power needed to operate the console indicators and controls. Two power supplies are used to increase the reliability of the equipment, and provision is made to disconnect a power supply automatically when its voltage output drops below a certain level. The circuitry which performs this action is shown in simplified form on figure 1-17. Across the output of each of the power supplies there is a control relay whose contacts apply 28 VDC to either a red or a green lamp in the "power supply on-failure indicator". When both power supplies are on and functioning properly, both of the control relays are energized and the green lamps are lit in both indicators. Then, if the voltage output of one power supply drops below a certain value, the control relay associated with that power supply is de-energized and the red lamp in the indicator for that power supply is lit. De-energizing

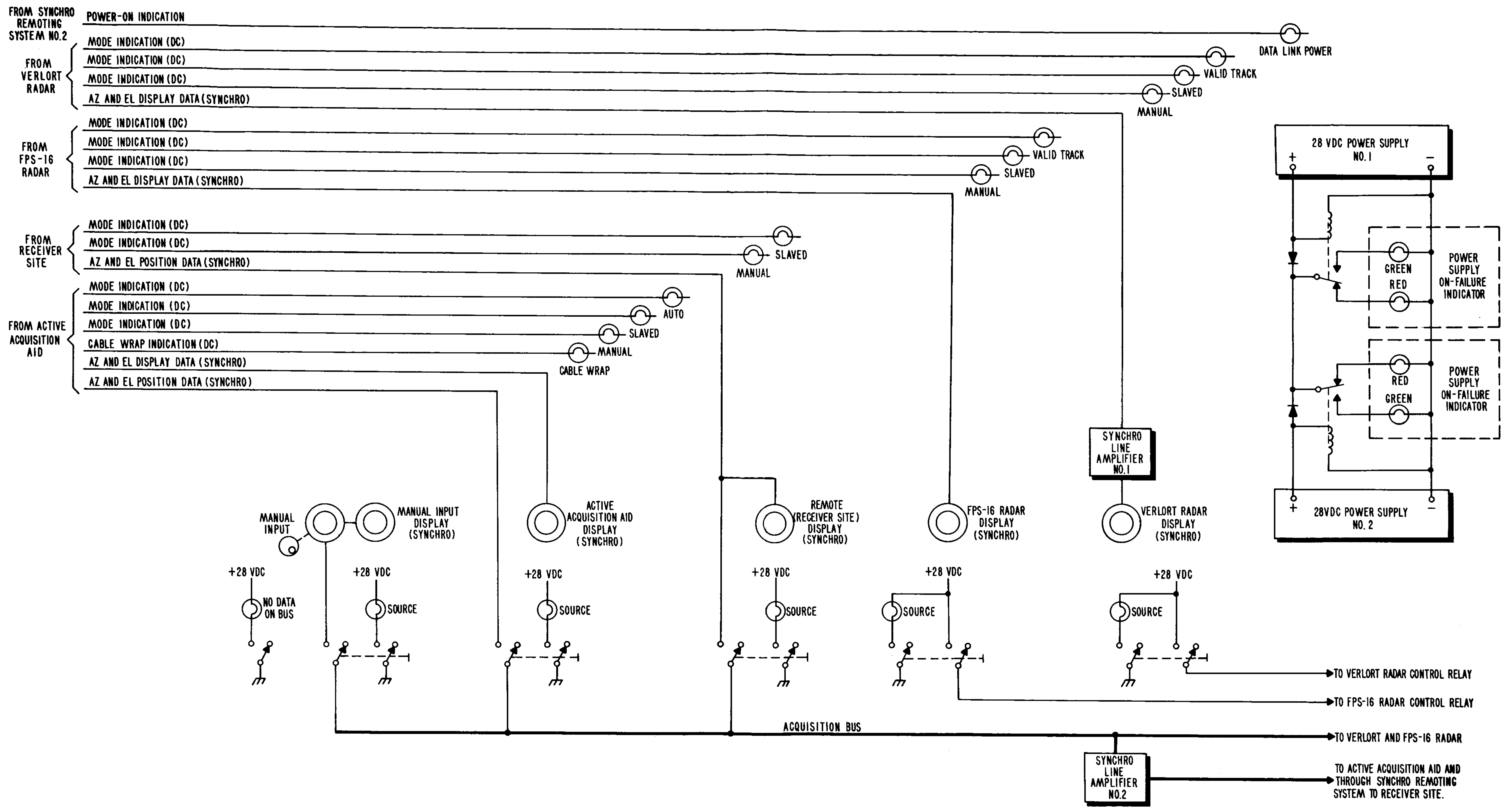


Figure 1-17. Radar Site Acquisition Data Console, Simplified Schematic Diagram

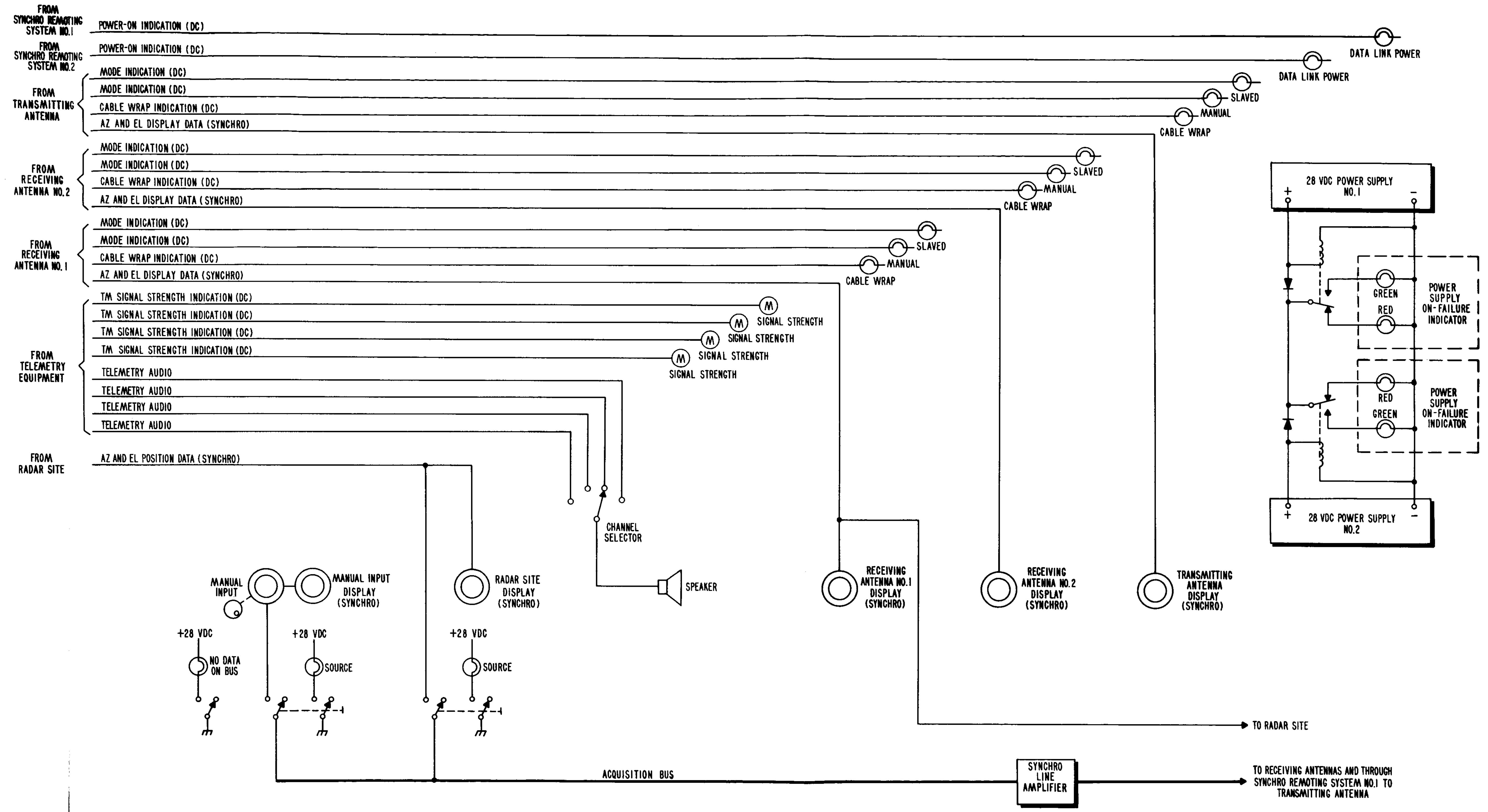


Figure 1-18. Receiver Site Acquisition Data Console, Simplified Schematic Diagram

the control relay also causes primary power to be removed from the malfunctioning power supply. (The red indicator lamp is supplied with power from the other, normally operating power supply.) Note that when one power supply has been turned on; the control circuit gives the same indication for a condition of one power supply turned on and one off as it does for both turned on and one malfunctioning.

(3). RECEIVER SITE ACQUISITION DATA CONSOLE

The receiver site acquisition data console is similar to the radar site console in that it contains indicator lights, synchro displays, and control switches and relays. The inputs other than primary power are d-c operating mode information, synchro display data, and synchro position data. The functions of these indicators, displays, and controls are explained below; a simplified schematic is shown in figure 1-18.

(a). The d-c indications from the transmitting antenna are "SLAVED" and "MANUAL" mode indications and a "CABLE WRAP" indication. The synchro data from this antenna is azimuth and elevation display data. The functions of these indications and the synchro data are the same as those of corresponding indications and data which come into the radar site console. (Refer to paragraph 1-3.C.(2).

(b). The d-c indications and synchro data from receiving antenna number 2 are the same as those from the transmitting antenna.

(c). The d-c indications and synchro data from receiving antenna number 1 are also the same as those from the transmitting antenna. However, in addition to being displayed on the receiver site console, display data from this antenna is transmitted to the radar site for use there as emergency slaving data.

(d). Indications of the strength of the r-f signals received by the site's four telemetry receivers come into the console from the telemetry equipment and are shown by signal strength meters, one for each of the indications. (Two of the telemetry receivers are connected to receiving antenna number 1 and the other two to receiving antenna Number 2.) For operation when data from the radar site is not available, the receiver site console operator selects whichever of the four signal strength indications is the stronger and clearer and adjusts the azimuth and elevation manual inputs to keep the indicated signal strength at a maximum. With the proper receiving antenna slaved to the acquisition bus (the "proper" antenna for this purpose is the one which is connected to the telemetry receiver whose signal strength indication is being used for positioning), this action amounts to pointing the antenna at the capsule. The same action also points the other receiving antenna and the transmitting antenna at the capsule, provided that they are slaved to the acquisition bus. As previously stated, the synchro display data from receiving antenna number 1 is supplied through synchro remoting system number 2 to the radar site. When the receiving antennas are being pointed in accordance with telemetry signal strength indications, the display data from receiving antenna number 1 can be used at the radar site as emergency slaving data. Audio signals also are received from the site telemetry equipment. The audio signals, one of which is selected by the audio channel selector switch, are used by the acquisition data console operator to confirm that the signal strength indications on the console are actually telemetry audio and not just noise.

(e). The only information coming to the receiver site console from the radar site is synchro position data. This data is available for switching onto the receiver site bus and also is displayed by a pair of synchro receivers.

(f). Power-on d-c indications from the transmitter-receiver units of synchro remoting systems numbers 1 and 2 at the receiver site come into the console.

(g). The manual input, the "NO DATA ON BUS" indicator, the source switches and indicators, and the 28 VDC power supply on the receiver site console are the same as the corresponding circuits on the radar site console, previously described. (Compare figures 1-17 and 1-18.)

(4). SYNCHRO LINE AMPLIFIERS

The purpose of the synchro line amplifiers is twofold: (1) to isolate synchro receivers from other receivers and from a synchro transmitter; and (2) to provide a high load impedance for synchro transmitters and a low source impedance for synchro receivers, thus making the synchro data less subject to degradation due to loading effects of the transmission lines and synchro receivers. Each synchro line amplifier has two, identical amplifier channels, one for azimuth data and one for elevation data. Each of the amplifier channels consists of two amplifier elements and a power supply. Each of the amplifier elements is, in itself, a four stage, feedback amplifier. The amount of feedback is adjusted so that each amplifier element has a voltage gain of one; thus each amplifier channel in the synchro line amplifier has a voltage gain of one, and the voltage applied to the synchro receivers connected to the amplifier is the same as that put out by the synchro transmitter connected to the amplifier. In this manner, isolation and a low impedance source for the synchro data are obtained without changing the voltage level of the data. For a detailed description of the synchro line amplifier, refer to the applicable equipment manual.

(5). ACTIVE ACQUISITION AID

(a). The active acquisition aid is an automatic angle-tracking device which provides acquisition data to the acquisition system for use by the other antennas on the site. It tracks the capsule in azimuth and elevation (but not in range) by means of the telemetry signals transmitted from the capsule, and puts out azimuth and elevation position and display synchro data.

(b). In addition to supplying data to the acquisition system, the active acquisition aid can be slaved (positioned in accordance with externally supplied azimuth and elevation data) to data on the acquisition bus.

(c). The salient characteristics of the active acquisition aid are as follows:

Operating modes: automatic, slaved, manual

Operating frequency: either one of any two, preset frequencies in the range 225-260 MC.

Tracking accuracy (at 10° per second tracking rate)

Azimuth: 0.5°

Elevation: 0.5° at angles greater than 15°

1.0° at angles between 10° and 15°

Antenna:

Type of array: quad helix

Polarization: circular, right-band sense

Elevation limits: minus 10° to plus 110°

Azimuth limit: 540°

Beamwidth: 20° at 3-db points

(d). For a complete functional description of the active acquisition aid, refer to the applicable equipment manual, listed in table 1-II.

(6). SYNCHRO REMOTING SYSTEMS

A synchro remoting system is needed to transmit synchro data over relatively long distances without degradation of the data. At Point Arguello two such systems, which are identical to each other, are employed. System number 1 consists of a transmitter-receiver near the receiver site acquisition data console and a second transmitter-receiver near the transmitting antenna servo rack at the transmitter site. System number 2 consists of a transmitter-receiver near the receiver site acquisition data console and another near the radar site acquisition data console. Thus, each complete system consists of two transmitters and two receivers. Both of the transmitters and receivers in each system handle two channels of data, azimuth and elevation. A simplified block diagram of synchro remoting system number 1 is shown in figure 1-19. Synchro signals supplied to the transmitter portions of the transmitter-

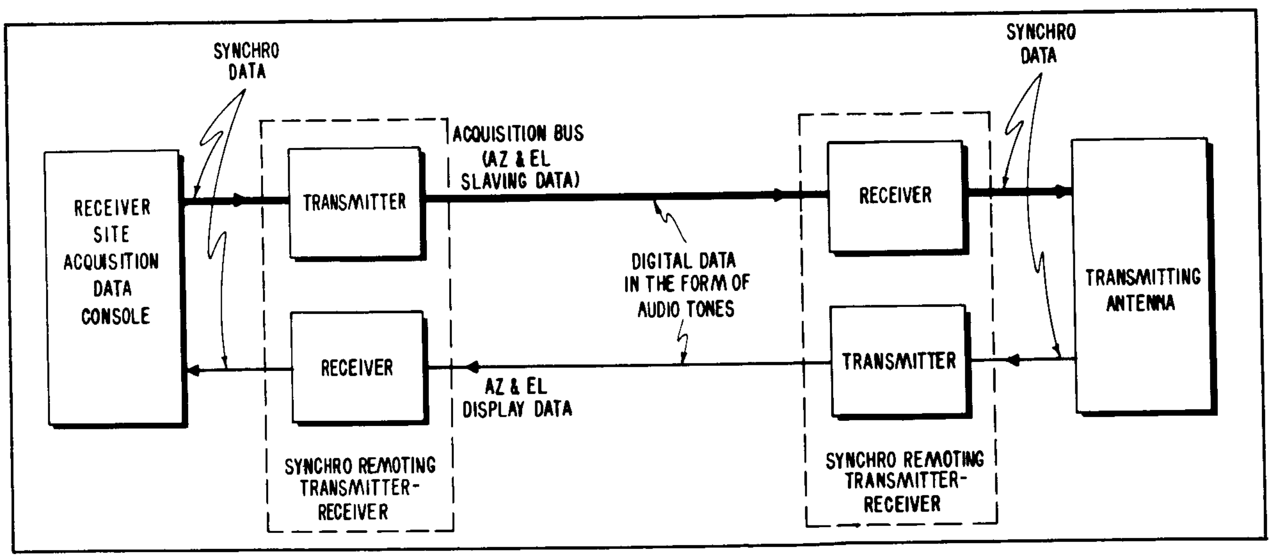


Figure 1-19. Synchro Remoting System No. 1, Simplified Block Diagram

receiver units (slaving data from the acquisition data console and display data from the transmitting antenna) are converted into frequency-multiplexed audio tones in a digital code. These audio tones are transmitted to the receivers, where they are decoded and synchro signals synthesized. The synchro signals synthesized by the receivers are, within the accuracy limitations of the system, the same as the synchro signals fed into the transmitter. In the remoting system, data is represented by frequency, not by voltage, and the accuracy of the system is, therefore, relatively independent of transmission line characteristics. For a complete description of the synchro remoting system, refer to the applicable equipment manual.

(7). ADDITIONAL EQUIPMENT

(a). SYNCHRO REFERENCE VOLTAGE TRANSFORMERS

The synchro reference voltage step-up transformer and synchro reference voltage step-down transformers are provided to reduce the amount of current transmitted over considerable distances. (See Section II for the location of the transformers.)

(b). MASTER-SLAVE RELAY PANEL

The master-slave relay panel mounted in the Verlort van contains the Verlort radar control relay. This control relay, energized from the acquisition data console, enables position data from the radar to be put onto the acquisition bus without separate cabling for the position data between the radar and the acquisition data console.

(c). FPS-16 RADAR CONTROL RELAY

The relay used to control the FPS-16 radar is in the FPS-16 data switch unit. This relay (K9011) enables the position data from the FPS-16 to be put onto the acquisition bus in the same manner as that from the Verlort. It also is energized from the acquisition data console.

(d). ANTENNA DRIVE POWER CUTOFF SWITCH AND WARNING LIGHT

The antenna drive power cutoff switch and warning light is mounted on the active acquisition aid antenna tower. When open, it disconnects antenna drive motor power. The warning light is lit whenever the switch is closed. (See Section II for the location of the cutoff switch and warning light.)

1-4. SITE IMPLEMENTATION

A. GENERAL

(1). This paragraph deals with the allocation, location, and housing of equipment for the acquisition system at the Point Arguello site.

(2). The nomenclature used in this manual for the antennas (other than radar) which are part of or are connected to the acquisition system differs slightly from the nomenclature used in the capsule communications and command control transmitting system manuals. For cross reference purposes the two sets of nomenclature are listed below:

ACQUISITION SYSTEM NOMENCLATURE	CAPSULE COMMUNICATIONS AND COMMAND CONTROL TRANSMITTING SYSTEM NOMENCLATURE
Active Acquisition Aid Antenna	-
Receiving Antenna Number 1	Receiving Antenna Number 1
Receiving Antenna Number 2	Receiving Antenna Number 2
Transmitting Antenna	Voice and Command Transmitting Antenna

B. EQUIPMENT ALLOCATION

The equipment which makes up the acquisition system at Point Arguello is listed in table 1-II.

C. SITE DESCRIPTION

(1). SITE LAYOUT

The Point Arguello site is made of three principal areas which are themselves called sites: the radar site, the receiver site, and the transmitter site. All three of these are shown on figure 1-20.

(a). RADAR SITE

Acquisition system equipment or equipment to which the acquisition system is connected at the radar site is in or near the LA-24 building, the FPS-16 building, and the Verlort radar van.

(b). RECEIVER SITE

At the receiver site, acquisition system and associated equipment is in or near the telemetry building.

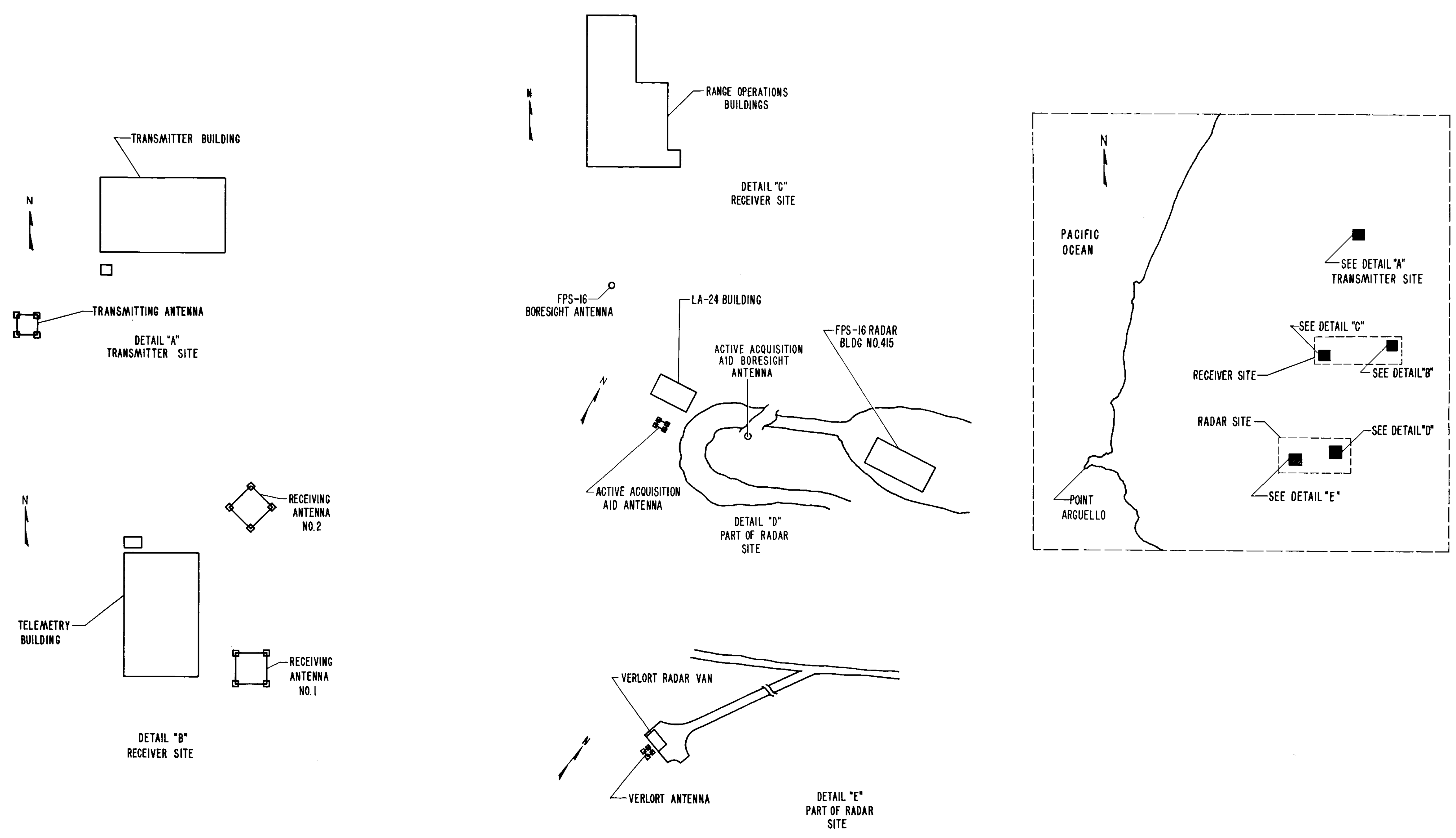


Figure 1-20. Site Layout, Point Arguello

(c). TRANSMITTER SITE

At the transmitter site, acquisition system and associated equipment is in or near the transmitter building.

(2). EQUIPMENT LOCATION - RADAR SITE

(a). ACQUISITION DATA CONSOLE

The radar site acquisition data console is in the LA-24 building as shown on figure 1-21.

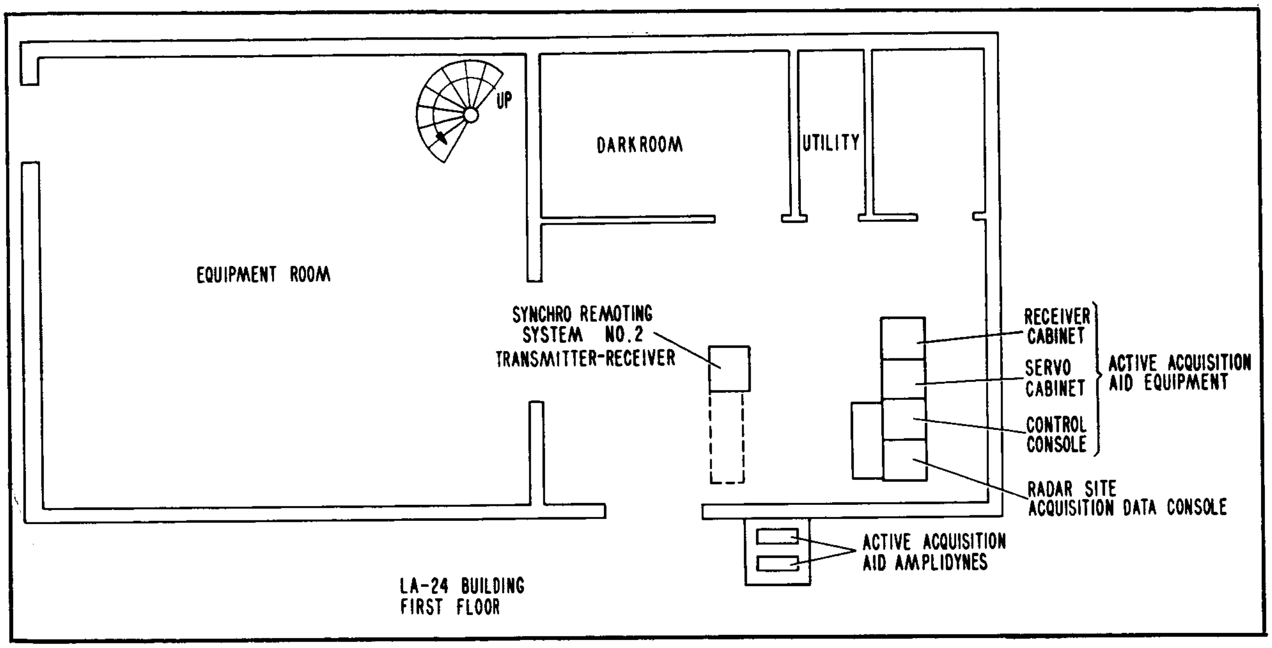


Figure 1-21. Acquisition System Equipment Layout, Radar Site LA-24 Building

(b). ACTIVE ACQUISITION AID

The active acquisition aid control console and receiver and servo cabinets are next to the acquisition data console in the LA-24 building (figure 1-21). The amplidynes are on a pad just outside the building. With the exception of the boresight transmitter and antenna, all other active acquisition aid equipment is on the antenna tower, located adjacent to the LA-24 building (figure 1-20). The boresight transmitter and antenna are on a pole, or tower, west of the FPS-16 building (figure 1-20).

(c). SYNCHRO REMOTING SYSTEM

The radar site transmitter-receiver of synchro remoting system number 2 is in the LA-24 building near the acquisition data console (figure 1-21).

(d). FPS-16 RADAR

The FPS-16 radar, to which the acquisition system is connected, is in the FPS-16 building. Two small items of equipment which are part of the acquisition system itself are in the FPS-16 building; these are a synchro reference voltage step-down transformer and a radar control relay. These items are in the locations shown on figure 1-22.

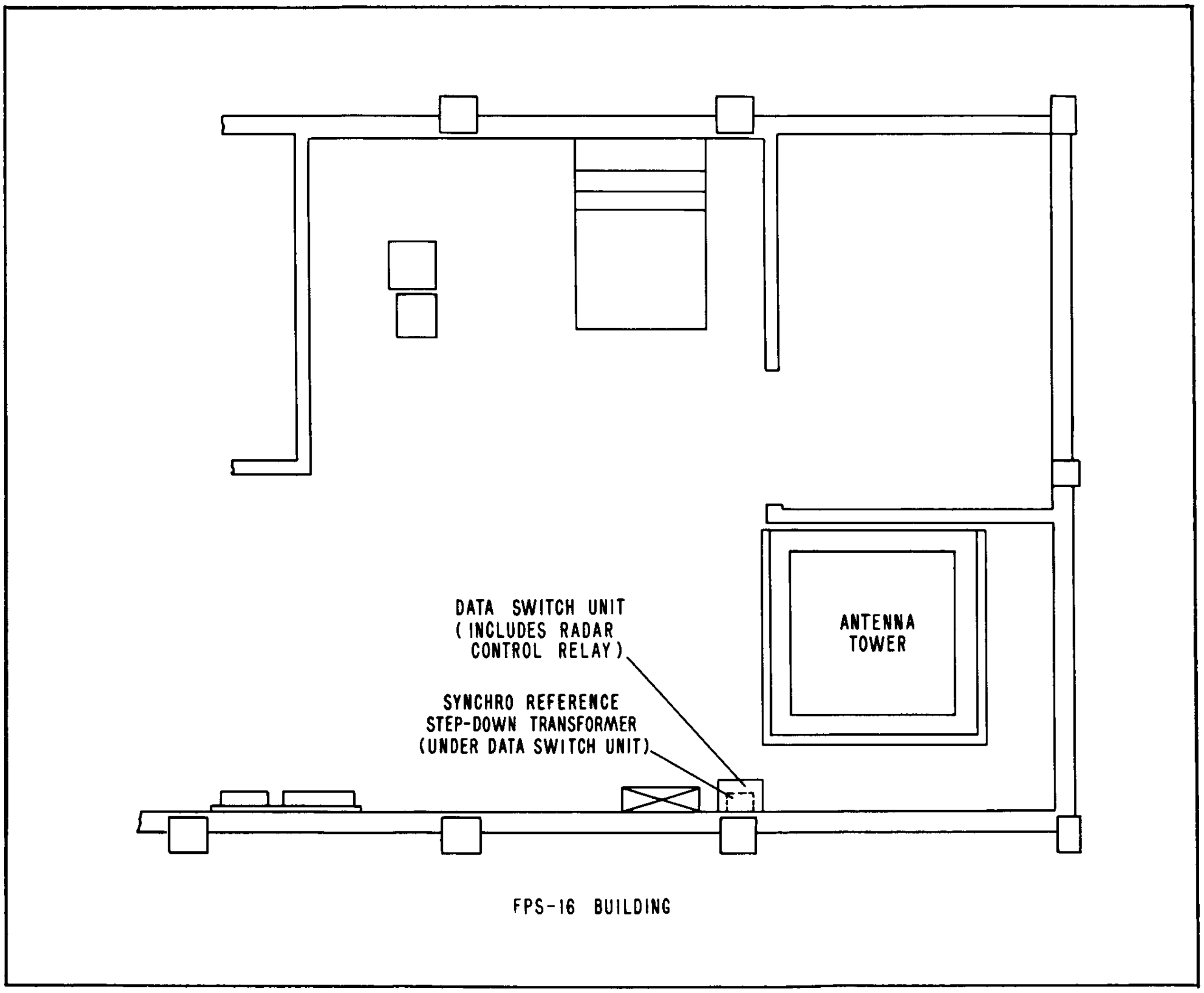


Figure 1-22. Acquisition System Equipment Layout, FPS-16 Building

(e). VERLORT RADAR

Acquisition system equipment in the Verlort radar van includes a radar control relay and a synchro reference voltage step-down transformer. These units are shown on figure 1-23.

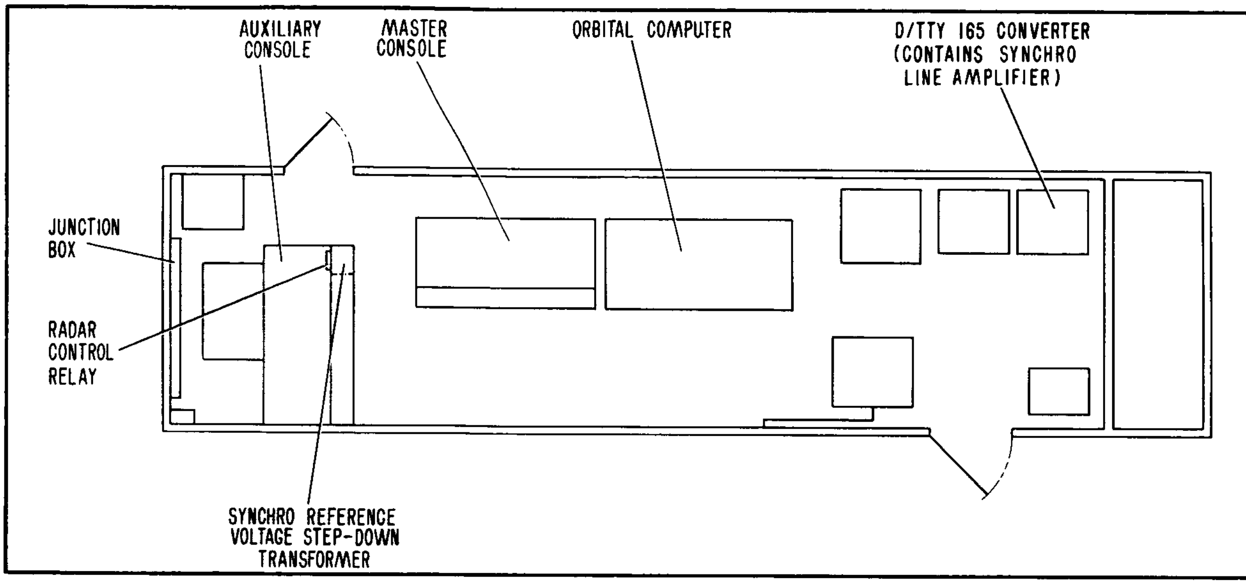


Figure 1-23. Acquisition System Equipment Layout, Verlort Radar Van

(f). SYNCHRO LINE AMPLIFIERS

There are a total of three synchro line amplifiers in the acquisition system at the radar site. For reference purposes these are arbitrarily numbered 1, 2, and 3. (The synchro line amplifiers at the receiver site are separately numbered.) Synchro line amplifiers number 1 and number 2 are in the acquisition data console. (See figure 1-2.) Synchro line amplifier number 3 is in the orbital computer in the Verlort radar van (figure 1-23).

(3). EQUIPMENT LOCATION - RECEIVER SITE

(a). ACQUISITION DATA CONSOLE

The receiver site acquisition data console is in the telemetry building basement in the location shown on figure 1-24.

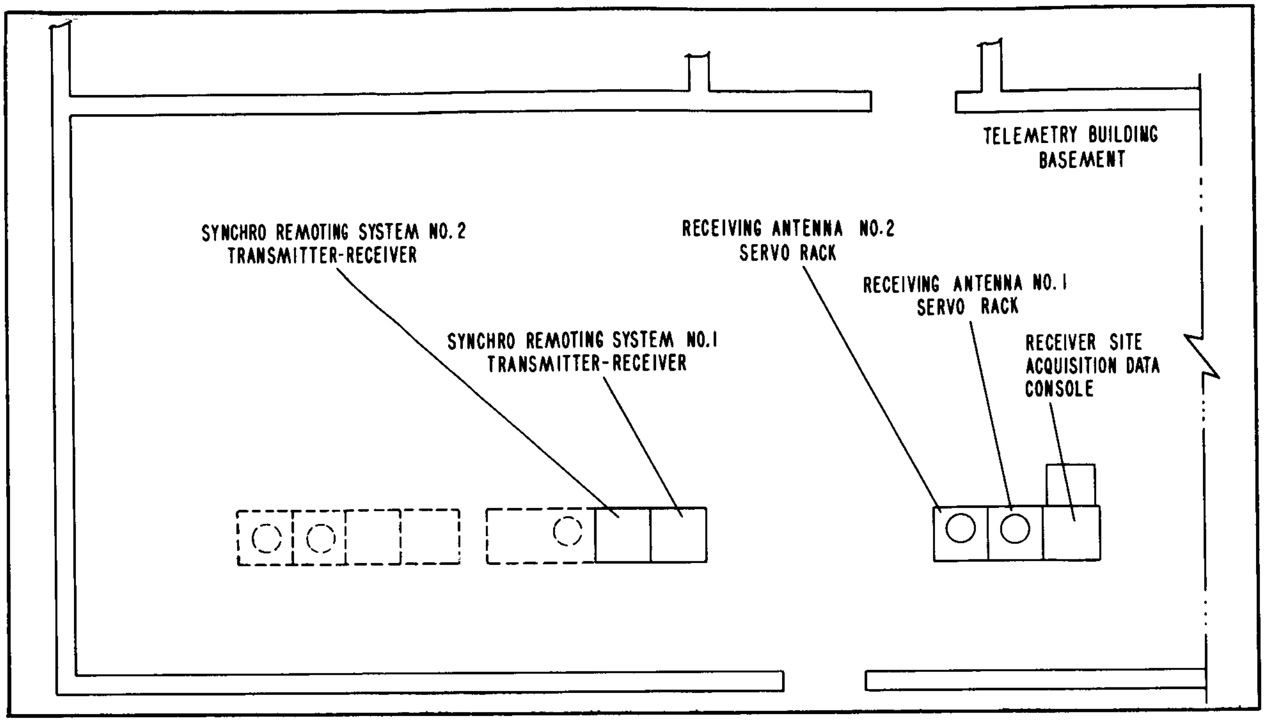


Figure 1-24. Acquisition System Equipment Layout, Receiver Site Telemetry Building

(b). RECEIVING ANTENNAS

The receiving antenna servo racks are in the telemetry building next to the acquisition data console. The antennas themselves are just outside the building as shown on figure 1-20. This equipment is not part of the acquisition system, but is connected to it.

(c). SYNCHRO REMOTING SYSTEMS

Transmitter-receiver units of synchro remoting systems number 1 and 2 are in the telemetry building basement in the locations shown on figure 1-24.

(d). SYNCHRO LINE AMPLIFIER

The synchro line amplifier at the receiver site is located in the acquisition data console (figure 1-24).

(4). EQUIPMENT LOCATION-TRANSMITTER SITE

(a). TRANSMITTING ANTENNA

The transmitting antenna servo rack is in the transmitter building (figure 1-25), and the transmitting antenna is just outside the building (figure 1-20).

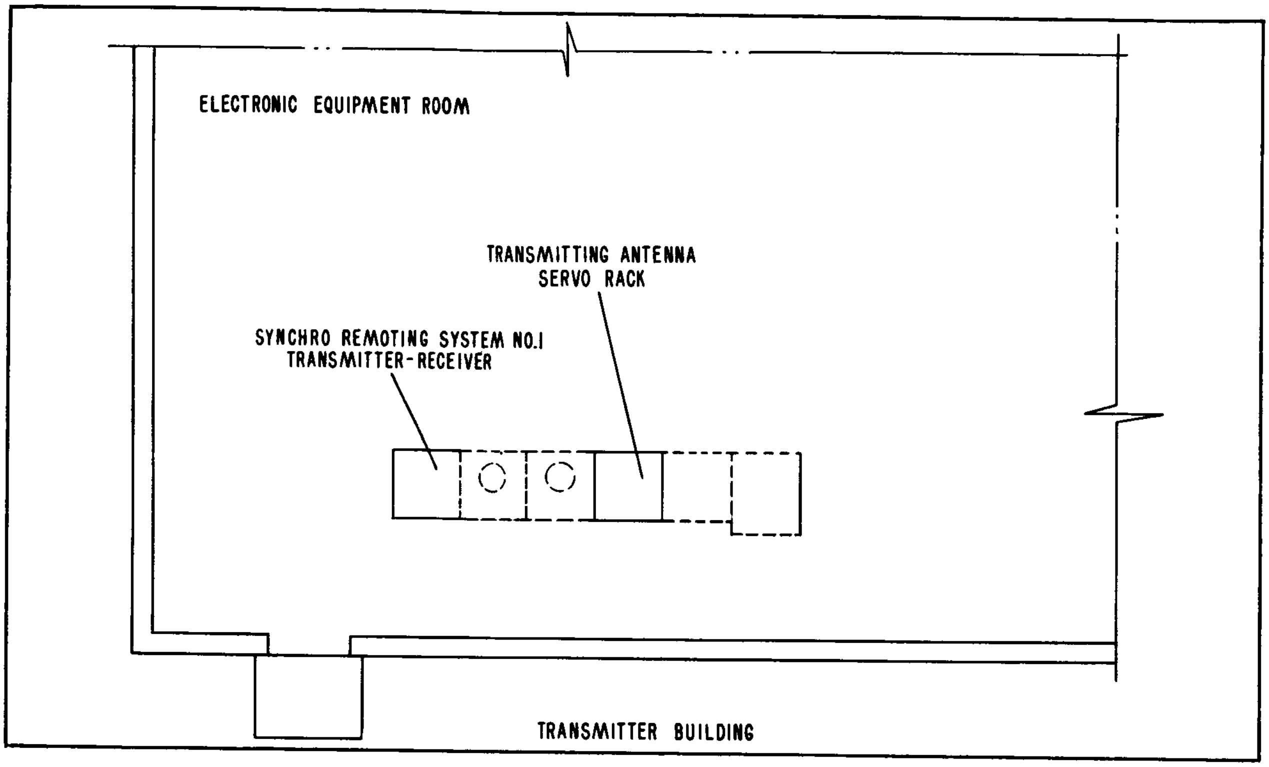


Figure 1-25. Acquisition System Equipment Layout, Transmitter Building

(b). <u>SYNCHRO REMOTING SYSTEM</u>

A transmitter-receiver of synchro remoting system number 1 is in the transmitter building near the transmitting antenna servo rack (figure 1-25).

(c). <u>SYNCHRO LINE AMPLIFIER</u>

There is one synchro line amplifier at the transmitter site. It is in the transmitting antenna servo rack. (See figures 1-25 and 2-7.)

SECTION II
INSTALLATION

2-1. GENERAL

This section comprises instructions and other information for installing the equipment which makes up the acquisition system. Equipment installation on building floors, on antenna towers, and in other equipment are covered in separate paragraphs.

2-2. EQUIPMENT INSTALLATION

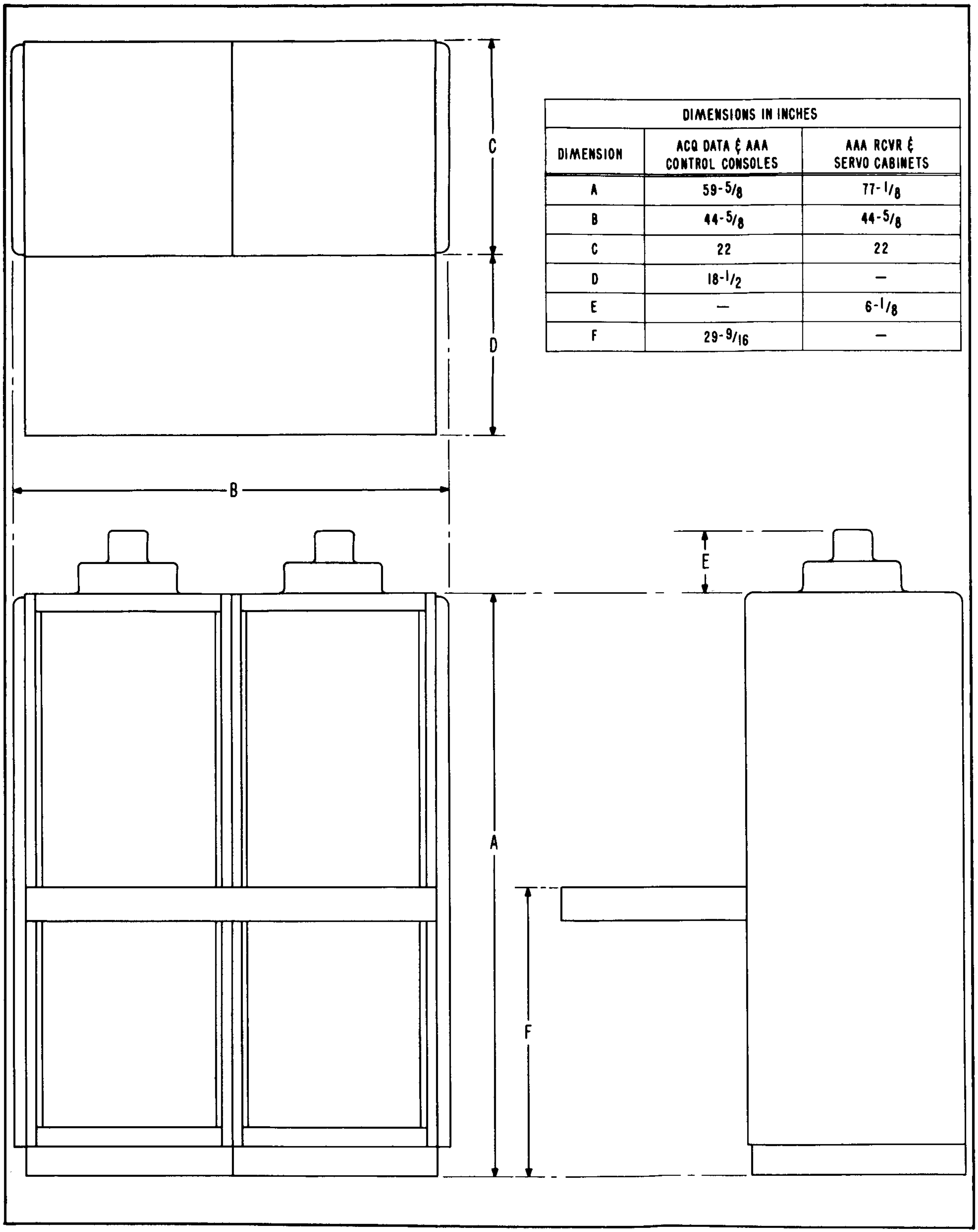
A. FLOOR MOUNTED EQUIPMENT

(1). CONSOLES AND CABINETS

The consoles and equipment cabinets in the acquisition system at the radar site comprise three units. The acquisition data console and the active acquisition aid control console are bolted together and installed as a single unit. The second unit is made up of the active acquisition aid receiver and servo cabinets bolted together and installed as a single unit. The third unit at the radar site is the synchro remoting transmitter-receiver. At the receiver site there are three major units of acquisition system equipment: the acquisition data console and two synchro remoting transmitter-receivers. At the transmitter site there is only the synchro remoting transmitter-receiver. Figures 1-21, 1-24, and 1-25 show the approximate locations of the acquisition system equipment in the site buildings. Figures 2-1 and 2-2 give the outline dimensions of the console and cabinet units. Note that these are composite illustrations and are not drawn to scale for all of the units. The console and cabinet units (with the exception of the intercom cabinet, which simply sits on top of the receiver site acquisition data console) are secured to the floor by anchor bolts. Mounting hole locations and details of the anchor bolt installations are shown on figure 2-3. A complete listing of the hardware required for mounting the units is given in table 2-1.

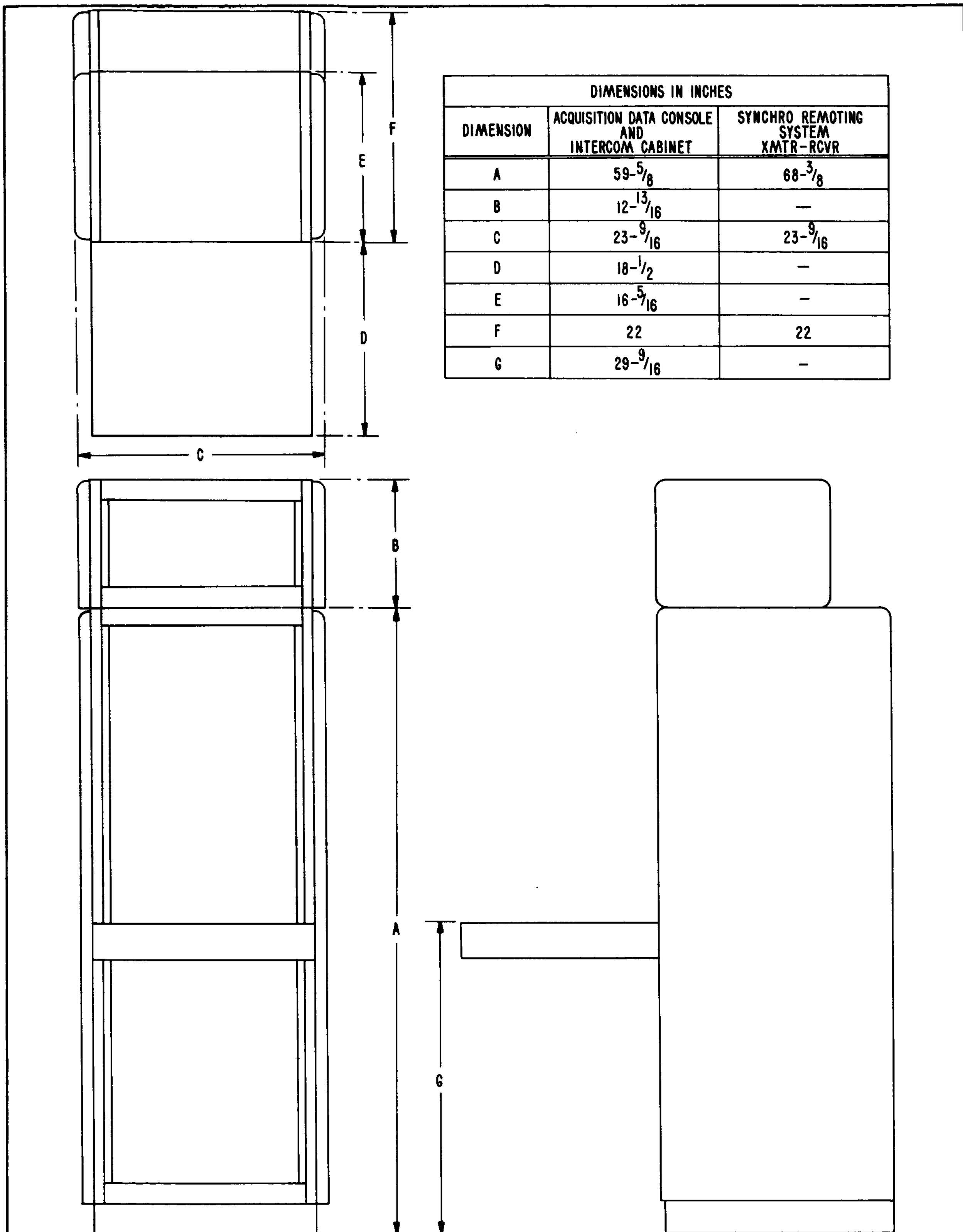
(2). AMPLIDYNES

Location of the active acquisition aid amplidynes is shown on figure 1-21. Each amplidyne is bolted to a steel channel, which is secured to a concrete pad with anchor bolts. See figures 2-3(B), 2-3(D), and 2-4 for details of the installation, and refer to table 2-I for the hardware required.



DIMENSIONS IN INCHES		
DIMENSION	ACQ DATA & AAA CONTROL CONSOLES	AAA RCVR & SERVO CABINETS
A	59-5/8	77-1/8
B	44-5/8	44-5/8
C	22	22
D	18-1/2	—
E	—	6-1/8
F	29-9/16	—

Figure 2-1. Radar Site Acquisition Data Console and Active Acquisition Aid Equipment Outline Dimensions



DIMENSIONS IN INCHES		
DIMENSION	ACQUISITION DATA CONSOLE AND INTERCOM CABINET	SYNCHRO REMOTING SYSTEM XMTR-RCVR
A	59-5/8	68-3/8
B	12-13/16	—
C	23-9/16	23-9/16
D	18-1/2	—
E	16-5/16	—
F	22	22
G	29-9/16	—

Figure 2-2. Synchro Remoting System Cabinet, Receiver Site Acquisition Data Console, and Intercom Cabinet Outline Dimensions

TABLE 2-I. EQUIPMENT MOUNTING HARDWARE

Hardware Name and Description	Part Number	Qty. per Unit
RADAR SITE ACTIVE DATA CONSOLE AND ACTIVE ACQUISITION AID CONTROL CONSOLE (See Figure 2-3(A))		
Anchor bolt, 5/16" lead insert	A683322-1	4
Bolt, 5/16" - 18 NC, 1" long	HK936S16-2018	4
Flat washer, 5/16"	HK779S20-A	4
Lock washer, 5/16"	HK779G20-E	4
ACTIVE ACQUISITION AID RECEIVER AND SERVO CABINETS (See Figure 2-3(A))		
(Same as acquisition data console and active acquisition aid control console.)		
RECEIVER SITE ACQUISITION DATA CONSOLE (See Figure 2-3(C))		
(Same as radar site acquisition data console and active acquisition aid control console.)		
SYNCHRO REMOTING TRANSMITTER-RECEIVERS (See Figure 2-3(C))		
(Same as radar site acquisition data console and active acquisition aid control console.)		
ACTIVE ACQUISITION AID AZIMUTH AMPLIDYNE (See figures 2-3(B), 2-3(D), and 2-4)		
Mounting channel	N683369-1	1
Anchor bolt, 5/16" lead insert	A683322-1	4
Bolt, 5/16" - 18 NC, 4-1/4" long	HK936S68-2018	4
Bolt, 5/16" - 18 NC, 1-1/4" long	HK936S20-2018	8
Flat washer, 5/16"	HK779S20-A	12
Lock washer, 5/16"	HK779G20-E	12
ACTIVE ACQUISITION AID ELEVATION AMPLIDYNE (See Figures 2-3(B), 2-3(D), and 2-4)		
(Same as active acquisition aid azimuth amplidyne.)		
ACTIVE ACQUISITION AID TRIPLEXER (See Figure 2-5)		
Support bracket	N653929-1	1
Bolt, 1/2" - 13 NC, 1-1/4" long	HK936S20-3212	4
Nut, 1/2" - 13 NC	HK775S32-13	4

TABLE 2-I. EQUIPMENT MOUNTING HARDWARE (Cont.)

Hardware Name and Description	Part Number	Qty. per Unit
ACTIVE ACQUISITION AID TRIPLEXER (See Figure 2-5) (Cont.)		
Flat washer, 1/2"	HK779S32-A	4
Lock washer, 1/2"	HK799G32-M	4
Bolt, 3/8" - 16 NC, 1-1/4" long	HK936S20-2416	4
Nut, 3/8" - 16 NC	HK775S24-16	4
Flat washer, 3/8"	HK779S24-A	4
Lock washer, 3/8"	HK779G24-M	4
ACTIVE ACQUISITION AID DIPLEXERS (See Figure 2-5)		
Beam support	L683396-1	1
Clip angle	C683397-1	4
Mounting plate	N683395-1	1
Bolt, 3/8" - 16 NC, 1-1/4" long	HK936S20-2416	29
Nut, 3/8" - 16 NC	HK775S24-16	29
Flat washer, 3/8"	HK779S24-A	29
Lock washer, 3/8"	HK779G24-M	29
ACTIVE ACQUISITION AID RF HOUSING (See Figure 2-5)		
Mounting bracket	SK-1000-402	1
Bolt, 3/8" - 16 NC, 1-1/2" long	HK936S24-2416	3
Bolt, 3/8" - 16 NC, 1-1/4" long	HK936S20-2416	6
Nut, 3/8" - 16 NC	HK775S24-16	9
Flat washer, 3/8"	HK779S24-A	9
Lock washer, 3/8"	HK779G24-M	9
ANTENNA DRIVE POWER CUTOFF SWITCH AND WARNING LIGHT (See Figure 2-5)		
Binder head screw, 10-32, 7/8" long	HK950S28-1032	3
Hex nut, 10-32	HK775S10-32	3
Lock washer, No. 10	HK799G10-M	3
ACTIVE ACQUISITION AID BORESIGHT TRANSMITTER (See Figure 2-6)		
Mounting channel	N689950-1	1
Bolt, 1/4" - 20 NC, 3/4" long	HK936S12-1620	6
Flat washer, 1/4"	HK779S16-A	6

TABLE 2-I. EQUIPMENT MOUNTING HARDWARE (Cont.)

Hardware Name and Description	Part Number	Qty. per Unit
ACTIVE ACQUISITION AID BORESIGHT TRANSMITTER (Cont.) (See Figure 2-6)		
Lock washer, 1/4"	HK799G16-H	6
Bolt, 3/8" - 16 NC, 7/8" long	HK936S14-2416	4
Nut, 3/8" - 16 NC	HK775S24-16	4
Flat washer, 3/8"	HK779S24-A	4
Lock washer, 3/8"	HK799G24-H	4
ACTIVE ACQUISITION AID BORESIGHT ANTENNA (See Figure 2-6)		
Antenna Support	653792-1	1
Mounting plate	653751-2	1
Clamp	689834-1	2
Bolt, 3/8" - 16 NC, 1" long	HK936S16-2416	6
Nut, 3/8" - 16 NC	HK775S24-16	4
Lock washer, 3/8"	HK799G24-M	10

B. EQUIPMENT ON TOWERS

(1). ANTENNA AND PEDESTAL

The active acquisition aid antenna and pedestal are installed on a tower constructed for that purpose at the radar site. The location of the tower is shown in figure 1-20. For instructions on the installation of the active acquisition aid antenna and pedestal, refer to the applicable equipment manual.

(2). RF HOUSING

The active acquisition aid RF housing is installed on the underside of the antenna tower platform in the location shown on figure 2-5. The unit is supported by a special bracket which is fastened to the tower platform. Refer to table 2-I for the installation hardware required.

(3). MULTIPLEXERS

The active acquisition aid multiplexers (triplexer and two diplexers) are mounted underneath the antenna tower platform. The triplexer is fastened to a

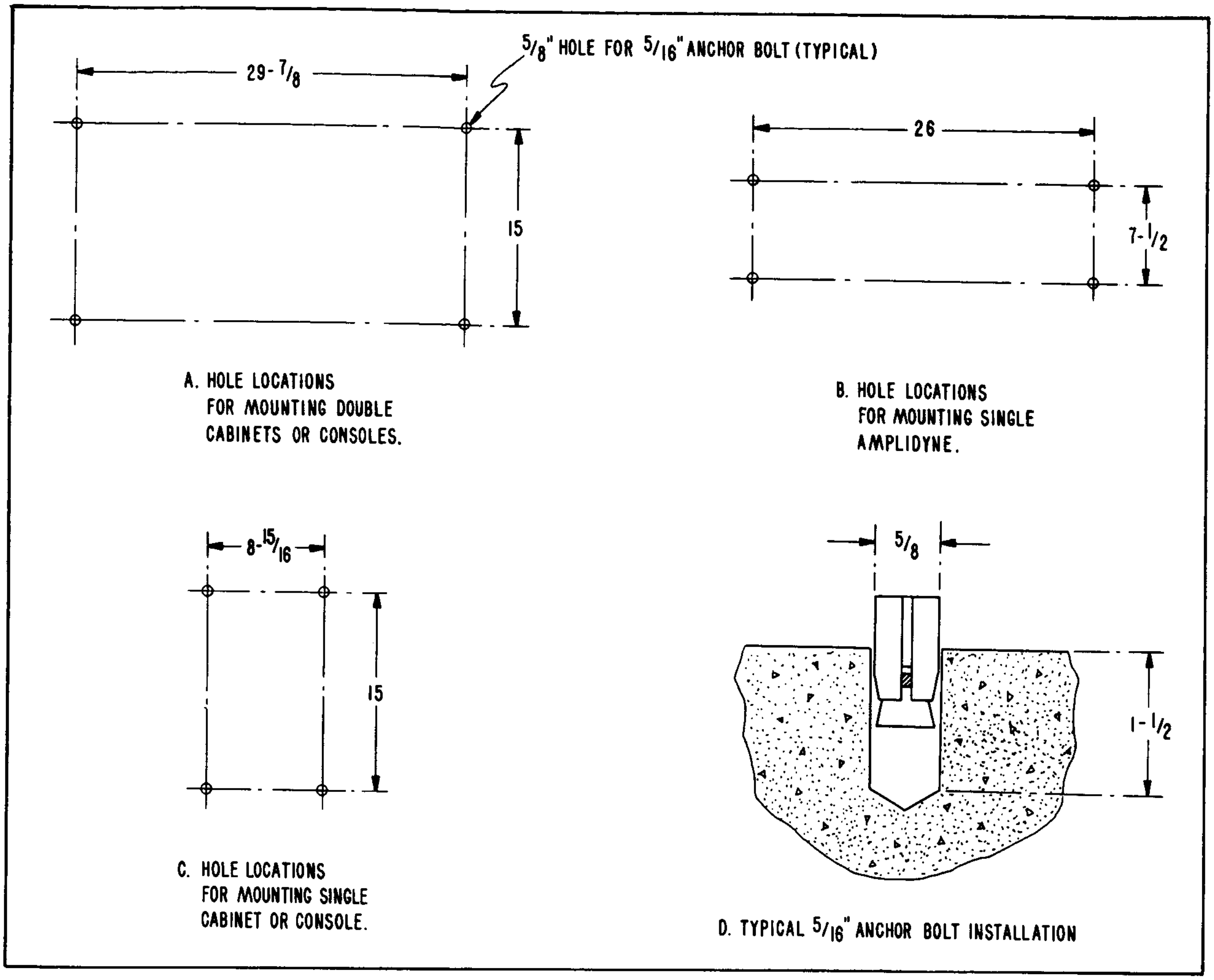


Figure 2-3. Floor and Pad Mounting Hole Locations

bracket, and the two diplexers are fastened to a common mounting plate. See figure 2-5 for the location of these components, and refer to table 2-I for the hardware required for installation.

(4). ANTENNA DRIVE POWER CUTOFF SWITCH AND WARNING LIGHT

The antenna drive power cutoff switch and warning light is mounted near the top of one of the ladders leading to the top of the active acquisition aid antenna platform. The required hardware is listed in table 2-I. See figure 2-5.

(5). BORESIGHT TRANSMITTER AND ANTENNA

The active acquisition aid boresight transmitter and antenna are

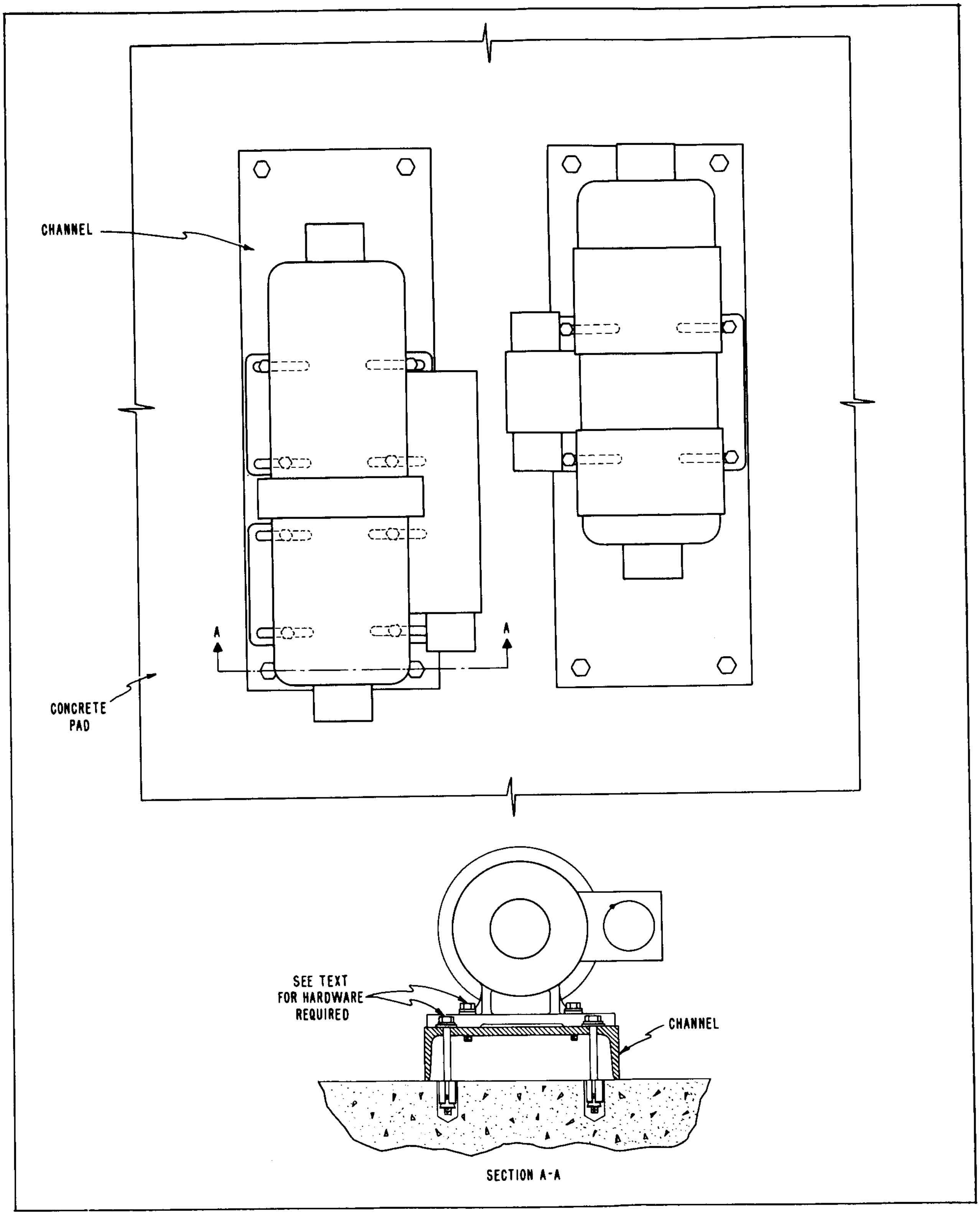


Figure 2-4. Amplidyne Installation

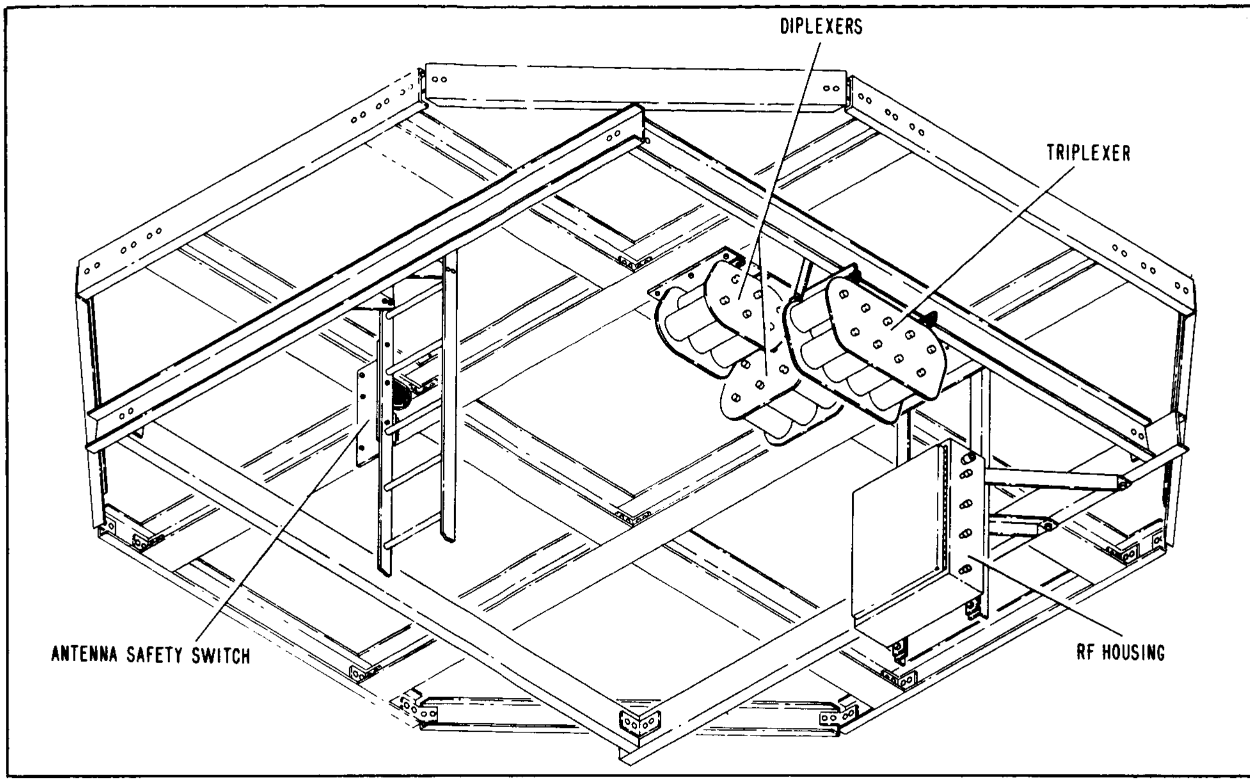


Figure 2-5. Active Acquisition Aid RF Equipment Installation

mounted on the boresight antenna tower; the transmitter on a bracket near the base of the tower, and the antenna on top of the tower. The location of the boresight tower is shown on figure 1-20. The bracket which supports the transmitter; the special support, mounting plate, and two clamps which mount the boresight antenna; and the required hardware are listed in table 2-I. Details of the installation are shown in figure 2-6.

C. SMALL COMPONENTS

(1). SYNCHRO REFERENCE VOLTAGE TRANSFORMERS

(a). The synchro reference voltage step-down transformer for the Verlort radar is installed in the auxiliary console (figure 1-23).

(b). In the FPS-16 radar building, the synchro reference transformer is located beneath the radar data switch unit. (See figure 1-22.)

(c). The active acquisition aid obtains its synchro reference voltage from the radar site acquisition data console. Therefore, there is no

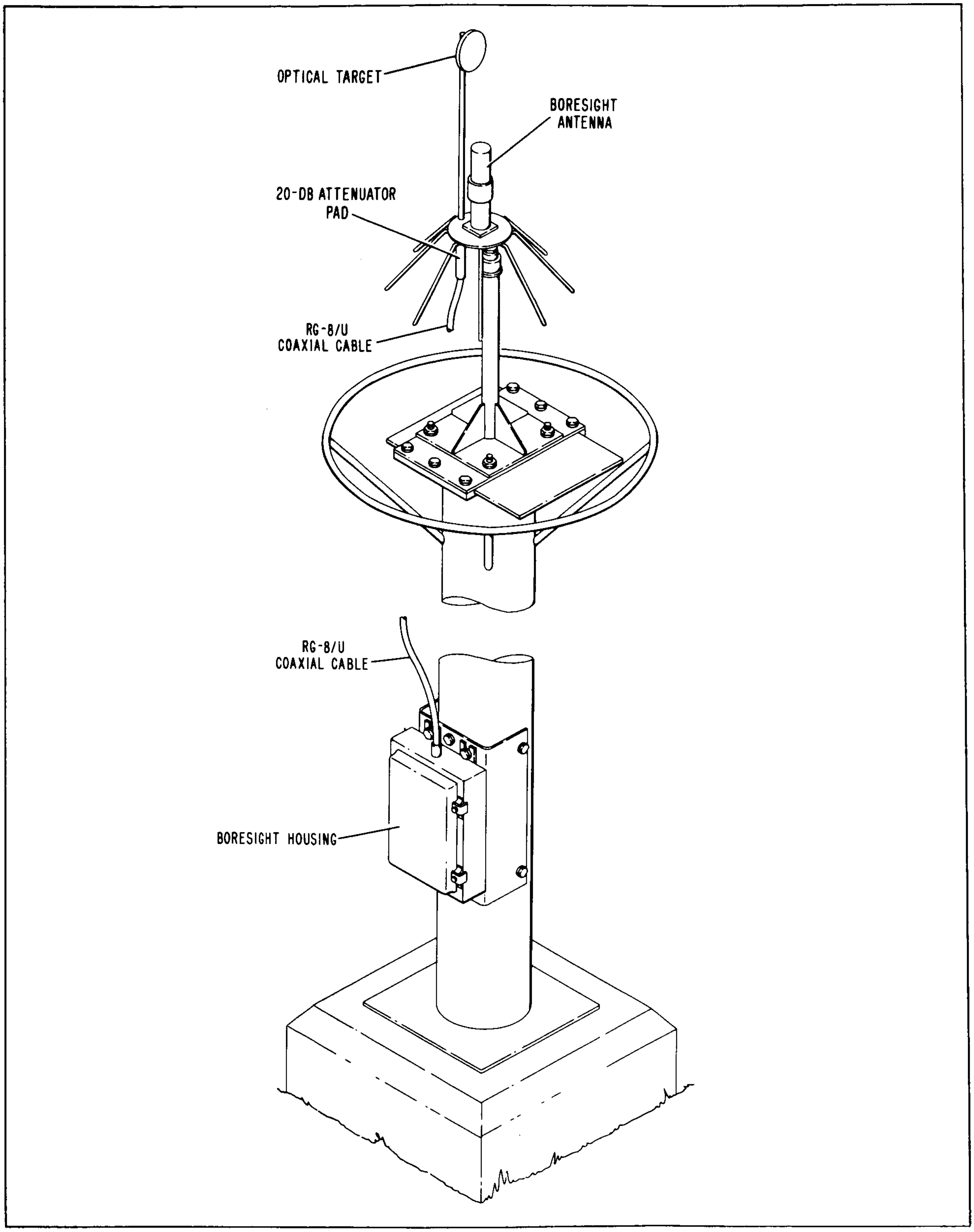


Figure 2-6. Active Acquisition Aid Boresight Transmitter and Antenna Installation

reference voltage transformer associated with the active acquisition aid. The reference voltage transformer for the acquisition data console is supplied as part of the console and requires no separate installation.

(d). The synchro remoting transmitter-receiver at the radar site, like the active acquisition aid, obtains its synchro reference voltage from the acquisition data console, and, therefore, has no reference voltage transformer associated with it.

(2). VERLORT RADAR CONTROL RELAY

The Verlort radar control relay (on the master-slave relay panel) is installed in the auxiliary console as shown in figure 1-23.

(3). FPS-16 RADAR CONTROL RELAY

The FPS-16 radar control relay is furnished as part of the FPS-16 radar data switch unit and requires no separate installation. For information on the data switch unit, refer to the Radar Tracking System Manual, MS-101.

(4). SYNCHRO LINE AMPLIFIERS

There are two synchro line amplifiers furnished to the site as separate equipment, and, therefore, require separate installation. The synchro line amplifier in the Verlort radar is installed in the D/TTY converter. See figure 1-23. The synchro line amplifier at the transmitter site is installed in the transmitting antenna servo rack as shown in figure 2-7.

2-3. INTERCONNECTING CABLING

A. ELECTRICAL INTERCONNECTIONS

An interconnecting cabling diagram for the acquisition system is included in Section VII (figure 7-24). This diagram shows all of the interconnections within the acquisition system and the interconnections between the acquisition system and equipment of other systems. Detailed interconnecting wiring information is not included in this manual. It is provided in a separate book (two volumes), the "Installation Wiring Information" chart, part number L683173-16.

B. CABLE INSTALLATION

The physical installation of equipment interconnecting cabling is not covered in this manual. Information on physical installation of interconnecting

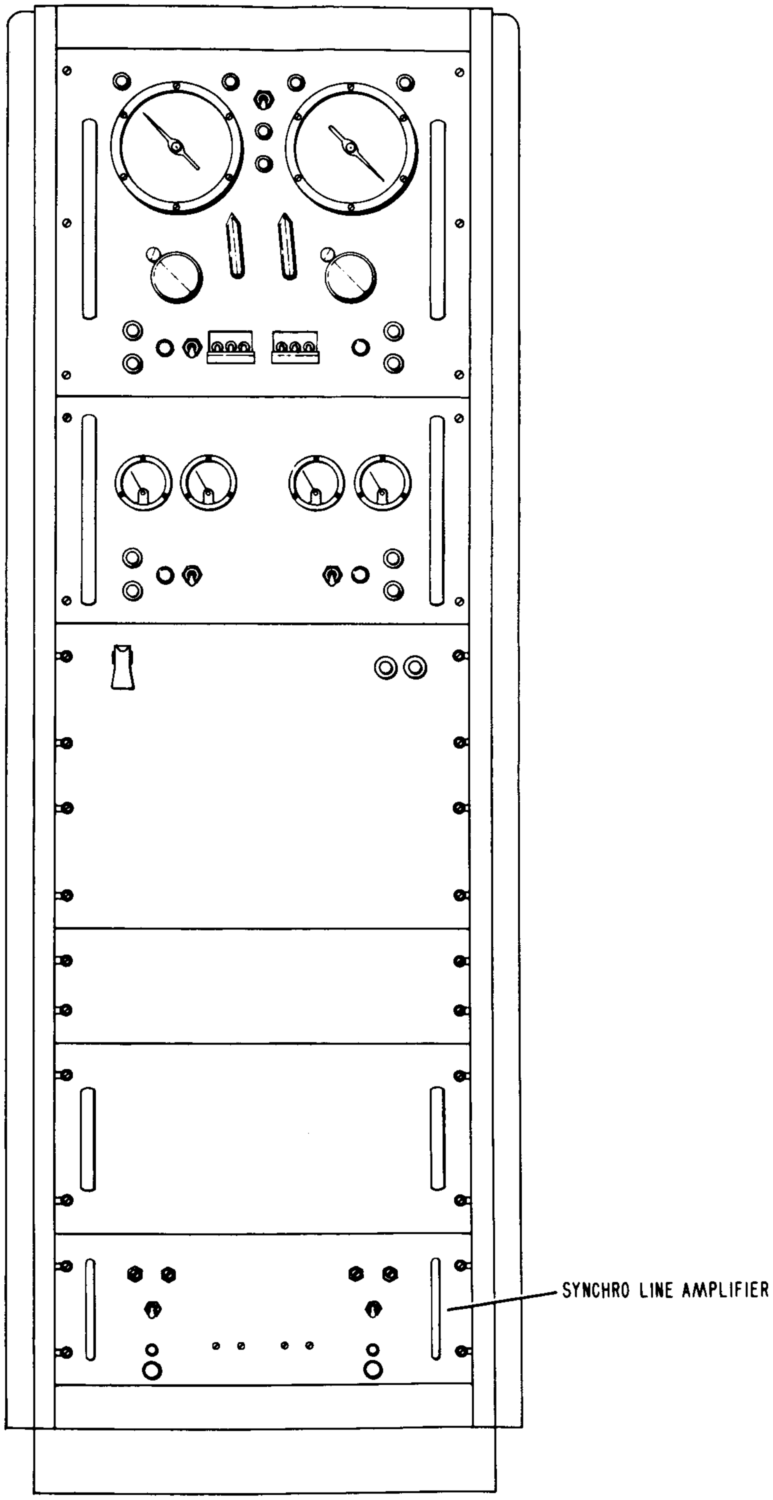


Figure 2-7. Synchro Line Amplifier in Transmitting Antenna Servo Rack

cabling is included in the installation wiring information chart (refer to the previous paragraph) and is provided directly to each site on separate drawings.

2-4. PRE-OPERATIONAL CHECKS

A. COMPONENT (UNIT) CHECKS

Pre-operational checks of the components of the acquisition system other than the acquisition data console are given in the individual equipment manuals, listed in table 1-II. Pre-operational checks for the acquisition data console are described in Section III of this manual.

B. SYSTEM CHECKS

No pre-operational checks are required for the overall acquisition system. Operational system checks are described in Section III. It should be kept in mind that any synchro circuit malfunctions which occur the first time the system checks are run are likely to be caused by incorrect interconnecting wiring of the synchro circuits. Refer to Section V and particularly to figure 5-1 for information on trouble shooting synchro circuit malfunctions.

SECTION III
SYSTEM OPERATION

3-1. GENERAL

A. This section contains a tabulation (table 3-I) and illustrations of the controls on the acquisition data consoles, initial and normal turn-on procedures for system equipment, system operational checks, and normal and emergency system operating procedures. Complete, detailed procedures are included for the acquisition data consoles only, since detailed procedures for other system equipment are in the various equipment manuals (listed in table 1-II). Except where noted otherwise, the information in this section is applicable both to the radar site and the receiver site.

B. For proper operation of the acquisition system, it is necessary that all operators involved, and particularly the acquisition data console operators, have a thorough knowledge and understanding of the makeup, capabilities, and limitations of the overall system and the equipment connected to it. Refer to Sections I and IV of this manual.

3-2. INITIAL TURN-ON PROCEDURE

The procedure described in this paragraph is to be followed the first time the equipment is turned on after installation or major repair. For initial turn-on procedures for equipment other than the acquisition data consoles, see the applicable equipment manuals, listed in table 1-II. Proceed as follows for the acquisition data consoles:

A. EXTERNAL POWER CONNECTIONS

(1). RADAR SITE

(a). With the acquisition data console circuit breaker on the site power panel turned on, check to see that 115 VAC is applied to console terminal board TB6001, terminals 1 and 2.

(b). Check to see that approximately 480 VAC is applied to the console on TB6001-7 and -8.

(c). Check the secondary voltage of transformer T6001. It should be between 115 and 120 VAC. If this voltage is less than 115 VAC, move the lead connected to terminal 4 of the transformer to terminal 5.

TABLE 3-I. OPERATING CONTROLS, INDICATORS, AND DISPLAYS

Name	Function
RADAR SITE ACQUISITION DATA PANEL (See Figure 3-1.)	
"28V SUPPLY" NO. 2 SWITCH AND ON-FAILURE INDICATOR	Turns on power supply No. 2 and indicates whether it is operating properly.
"28V SUPPLY" NO. 1 SWITCH AND ON-FAILURE INDICATOR	Turns on power supply No. 1 and indicates whether it is operating properly.
"NO DATA ON BUS" INDICATOR	Indicates that none of the "SOURCE" switches has been depressed.
"DATA LINK POWER" INDICATOR	Indicates that primary power has been applied to the radar site xmtr-rcvr unit of synchro remoting system No. 2.
ACTIVE ACQUISITION AID "SOURCE" SWITCH	Connects data from the active acquisition aid to the acquisition bus.
ACTIVE ACQUISITION AID MODE INDICATORS	Indicate whether the active acquisition aid is in automatic tracking, slaved, or manual mode of operation.
VERLORT RADAR MODE INDICATORS	Indicate whether the Verlort radar is in automatic tracking, slaved, or manual mode of operation.
ACTIVE ACQUISITION AID "CABLE WRAP" INDICATORS	Indicate whether the active acquisition aid antenna is clockwise or counter-clockwise from the midpoint of its 540° azimuth travel.
ACTIVE ACQUISITION AID "AZIMUTH" DISPLAY	Shows the azimuth angle of the active acquisition aid antenna.
ACTIVE ACQUISITION AID "ELEVATION" DISPLAY	Shows the elevation angle of the active acquisition aid antenna.
VERLORT RADAR "AZIMUTH" DISPLAY	Shows the azimuth angle of the Verlort antenna.
VERLORT RADAR "ELEVATION" DISPLAY	Shows the elevation angle of the Verlort antenna.
FPS-16 RADAR "AZIMUTH" DISPLAY	Shows the azimuth angle of the FPS-16 radar.

TABLE 3-I. OPERATING CONTROLS, INDICATORS, AND DISPLAYS (Cont.)

Name	Function
RADAR SITE ACQUISITION DATA PANEL (See Figure 3-1.) (Cont.)	
FPS-16 RADAR "ELEVATION" DISPLAY	Shows the elevation angle of the FPS-16 antenna.
REMOTE SITE "AZIMUTH" DISPLAY	Shows the azimuth angle of receiving antenna No. 1.
REMOTE SITE "ELEVATION" DISPLAY	Shows the elevation angle of receiving antenna No. 1.
FPS-16 RADAR MODE INDICATORS	Indicate whether the FPS-16 is in automatic tracking, slaved, or manual mode of operation.
REMOTE SITE MODE INDICATORS	Show whether data on bus at receiver site is from radar site or manual input at receiver site console.
REMOTE SITE "SOURCE" SWITCH	Connects data from receiving antenna No. 1 to radar site acquisition bus.
FPS-16 RADAR "SOURCE" SWITCH	Connects data from the FPS-16 to the acquisition bus.
MANUAL INPUT "AZIMUTH" DISPLAY	Shows angle to which the azimuth manual input transmitter has been turned.
MANUAL INPUT "SOURCE" SWITCH	Connects data from the manual input transmitters to the acquisition bus.
AZIMUTH "MANUAL INPUT" SYNCHRO HANDWHEEL	Turns the azimuth manual input transmitter.
VERLORT RADAR "SOURCE" SWITCH	Connects data from the Verlort to the acquisition bus.
MANUAL INPUT "ELEVATION" DISPLAY	Shows angle to which the elevation manual input transmitter has been turned.
ELEVATION "MANUAL INPUT" SYNCHRO HANDWHEEL	Turns the elevation manual input transmitter.
RECEIVER SITE ACQUISITION DATA PANEL (See Figure 3-2.)	
"28V SUPPLY" NO. 2 SWITCH AND ON-FAILURE INDICATOR	Turns on power supply No. 2 and indicates whether it is operating properly.
"28V SUPPLY" NO. 1 SWITCH AND ON-FAILURE INDICATOR	Turns on power supply No. 1 and indicates whether it is operating properly.

TABLE 3-I. OPERATING CONTROLS, INDICATORS, AND DISPLAYS (Cont.)

Name	Function
RECEIVER SITE ACQUISITION DATA PANEL (See Figure 3-2.) (Cont.)	
"DATA LINK POWER NO. 1" INDICATOR	Indicates that primary power has been applied to rcvr site xmtr-rcvr unit of synchro remoting system No. 1.
"DATA LINK POWER NO. 2" INDICATOR	Indicates that primary power has been applied to rcvr site xmtr-rcvr unit of synchro remoting system No. 2.
XMTR ANT. MODE INDICATORS	Indicate whether the transmitting antenna is in slaved or manual mode of operation.
RADAR SITE "SOURCE" SWITCH	Connects data from the radar site to the rcvr site bus.
"NO DATA ON BUS" INDICATOR	Indicates that neither of the "SOURCE" switches has been depressed.
"RADAR SITE "ELEVATION" DISPLAY	Shows the elevation angle of the data on the radar site acquisition bus.
XMTR ANT. "ELEVATION" DISPLAY	Shows the elevation angle of the transmitting antenna.
RADAR SITE "AZIMUTH" DISPLAY	Shows the azimuth angle of the data on the radar site acquisition bus.
XMTR ANT. "CABLE WRAP" INDICATORS	Indicate whether the transmitting antenna is clockwise or counterclockwise from the midpoint of its 540° azimuth travel.
XMTR ANT. "AZIMUTH" DISPLAY	Shows the azimuth angle of the transmitting antenna.
RCVR ANT. NO. 1 "CABLE WRAP" INDICATORS	Indicate whether receiving antenna No. 1 is clockwise or counterclockwise from the midpoint of its 540° azimuth travel.
RCVR ANT. NO. 1 "AZIMUTH" DISPLAY	Shows the azimuth angle of receiving antenna No. 1.
RCVR ANT. NO. 2 "CABLE WRAP" INDICATORS	Indicate whether receiving antenna No. 2 is clockwise or counterclockwise from the midpoint of its 540° azimuth travel.
RCVR ANT. NO. 2 "AZIMUTH" DISPLAY	Shows the azimuth angle of receiving antenna No. 2.
RCVR ANT. NO. 1 "ELEVATION" DISPLAY	Shows the elevation angle of receiving antenna No. 1.
RCVR ANT. NO. 2 "ELEVATION" DISPLAY	Shows the elevation angle of receiving antenna No. 2.

TABLE 3-I. OPERATING CONTROLS, INDICATORS, AND DISPLAYS (Cont.)

Name	Function
RECEIVER SITE ACQUISITION DATA PANEL (See Figure 3-2.) (Cont.)	
RCVR ANT. NO. 2 MODE INDICATORS	Indicate whether receiving antenna No. 2 is in slaved or manual mode of operation.
RCVR ANT. NO. 1 MODE INDICATORS	Indicate whether receiving antenna No. 1 is in the slaved or manual mode of operation.
TM CHANNEL SELECTOR SWITCH	Selects one of four sources of audio signal for monitoring and applies 28 VDC to pilot lamp adjacent to signal strength meter which is connected to the audio source selected.
MANUAL INPUT "AZIMUTH" DISPLAY	Shows angle to which the azimuth manual input transmitter has been turned.
TM AUDIO "VOLUME" CONTROL	Adjusts volume of audio signal being monitored.
AZIMUTH "MANUAL INPUT" SYNCHRO HANDWHEEL	Turns the azimuth manual input transmitter.
MANUAL INPUT "SOURCE" SWITCH	Connects data from the manual input transmitters to the acquisition bus.
ELEVATION "MANUAL INPUT" SYNCHRO HANDWHEEL	Turns the elevation manual input transmitter.
MANUAL INPUT "ELEVATION" DISPLAY	Shows angle to which the elevation manual input transmitter has been turned.
DUAL POWER SUPPLY (See Figure 3-3.)	
OFF-ON SWITCH	Controls application of primary power to the dual power supply.
FUSES	Contain primary power line fuses and indicators to show when a fuse is blown.
POWER-ON INDICATOR	Indicates the application of primary power to the dual power supply.
SYNCHRO LINE AMPLIFIER (See Figure 3-4.)	
CHANNEL "OFF-ON" SWITCHES	Each applies power to one amplifier channel.
CHANNEL LINE "COMPENSATION" CONTROLS	Each pair adjusts the gain and balance of one amplifier channel.
CHANNEL "2 AMP" FUSES	Primary power line fuses - one for each channel.

TABLE 3-I. OPERATING CONTROLS, INDICATORS, AND DISPLAYS (Cont.)

Name	Function
SYNCHRO LINE AMPLIFIER (See Figure 3-4.) (Cont.)	
CHANNEL "POWER" ON INDICATORS	Indicate that channel primary power has been turned on.
INTERCOM PANEL (See Figure 3-5.)	
Refer to Intrasite PBX and Intercom System Manual, MS-109.	
RECEIVER SITE ACQUISITION DATA CONSOLE SIGNAL STRENGTH METER PANEL (See Figure 3-6.)	
RCVR ANT. NO. 2 FREQ B TLM RCVR "SIGNAL STRENGTH" METER	Indicates strength of signal at frequency B telemetry receiver connected to receiving antenna No. 2.
RCVR ANT. NO. 1 FREQ B TLM RCVR "SIGNAL STRENGTH" METER	Indicates strength of signal at frequency B telemetry receiver connected to receiving antenna No. 1.
RCVR ANT. NO. 2 FREQ A TLM RCVR "SIGNAL STRENGTH" METER	Indicates strength of signal at frequency A telemetry receiver connected to receiving antenna No. 2.
RCVR ANT. NO. 1 FREQ A TLM RCVR" SIGNAL STRENGTH" METER	Indicates strength of signal at frequency A telemetry receiver connected to receiving antenna No. 1.
CALIBRATION CONTROLS	Permit calibration of the meters to indicate actual signal strength.
PILOT LAMPS	Correlate audio signal source with signal strength indication.
AUDIO AMPLIFIER (See Figure 3-7.)	
SPEAKER "OFF-ON" SWITCH	Connects audio output to speaker.
"PHONE JACK"	Permits monitoring audio with headset.
"1 AMP" FUSE	Primary power fuse for audio amplifier.
AMPLIFIER "OFF-ON" SWITCH	Primary power switch for audio amplifier.

(2). RECEIVER SITE

(a). With the acquisition data console circuit breaker on the site power panel off, remove all wires except the external power leads from console terminal board TB6001, terminals 1 and 2.

(b). Turn the circuit breaker on and check to see that 115 VAC is applied to console terminals TB6001-1 and TB6001-2. TB6001-1 should be connected to the "hot" wire, and TB6001-2 to the neutral wire. Measure from the terminals to console ground to ascertain which terminal is "hot." (There should be 115 VAC between TB6001-1 and console ground, and no or very little voltage between TB6001-2 and console ground.)

(c). Turn the circuit breaker off and reconnect all console wiring to terminals TB6001-1 and TB6001-2.

B. 28 VDC POWER SUPPLY

(1). Turn on the acquisition data console circuit breaker on the site power panel.

(2). Turn on the OFF-ON switch on the dual power supply panel (figure 3-3).

(3). Depress the "28V SUPPLY" number 1 switch on the acquisition data panel (figure 3-1 or 3-2). This action turns on power supply number 1. The on-failure indicator for power supply number 1 should be green and the indicator for power supply number 2 should be red.

(4). Remove the display screens from both of the on-failure indicators. Check to see that all color filters are in place (two red and two green in each indicator). The two lamps in the power supply number 1 indicator with green color filters should be lit, and the two lamps in the power supply number 2 indicator with red color filters should be lit.

(5). Check and, if necessary, adjust the output voltage of power supply number 1 in accordance with the instructions in paragraph 5-4.D.(2).

(6). Turn off power supply number 1 by turning off the OFF-ON switch on the dual power supply panel.

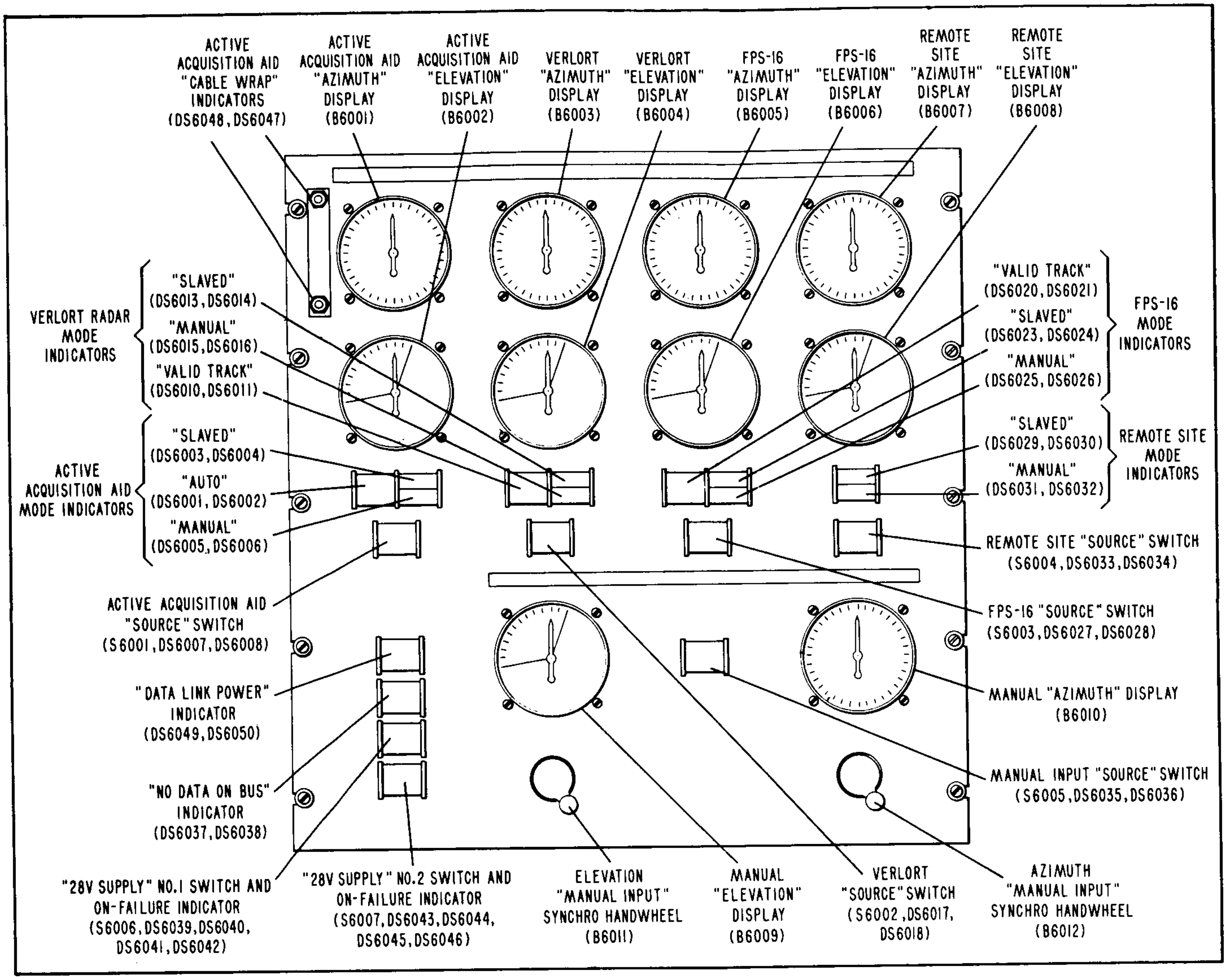


Figure 3-1. Radar Site Acquisition Data Panel

Note

Because of the long time constant of the power supply filter, several seconds are required after turning off the power supply before the holding coil of the "28V SUPPLY" switch releases.

(7). Turn on the OFF-ON switch on the dual power supply panel.

(8). Depress the "28V SUPPLY" number 2 switch on the acquisition data panel. This action turns on power supply number 2. The on-failure indicator for power supply number 2 should be green and the indicator for power supply number 1 should be red.

(9). Check the indicators of both power supplies to see that both of the lamps with green color filters in power supply number 2 indicator are lit and that both of the lamps with the red color filters in the power supply number 1 indicator are lit.

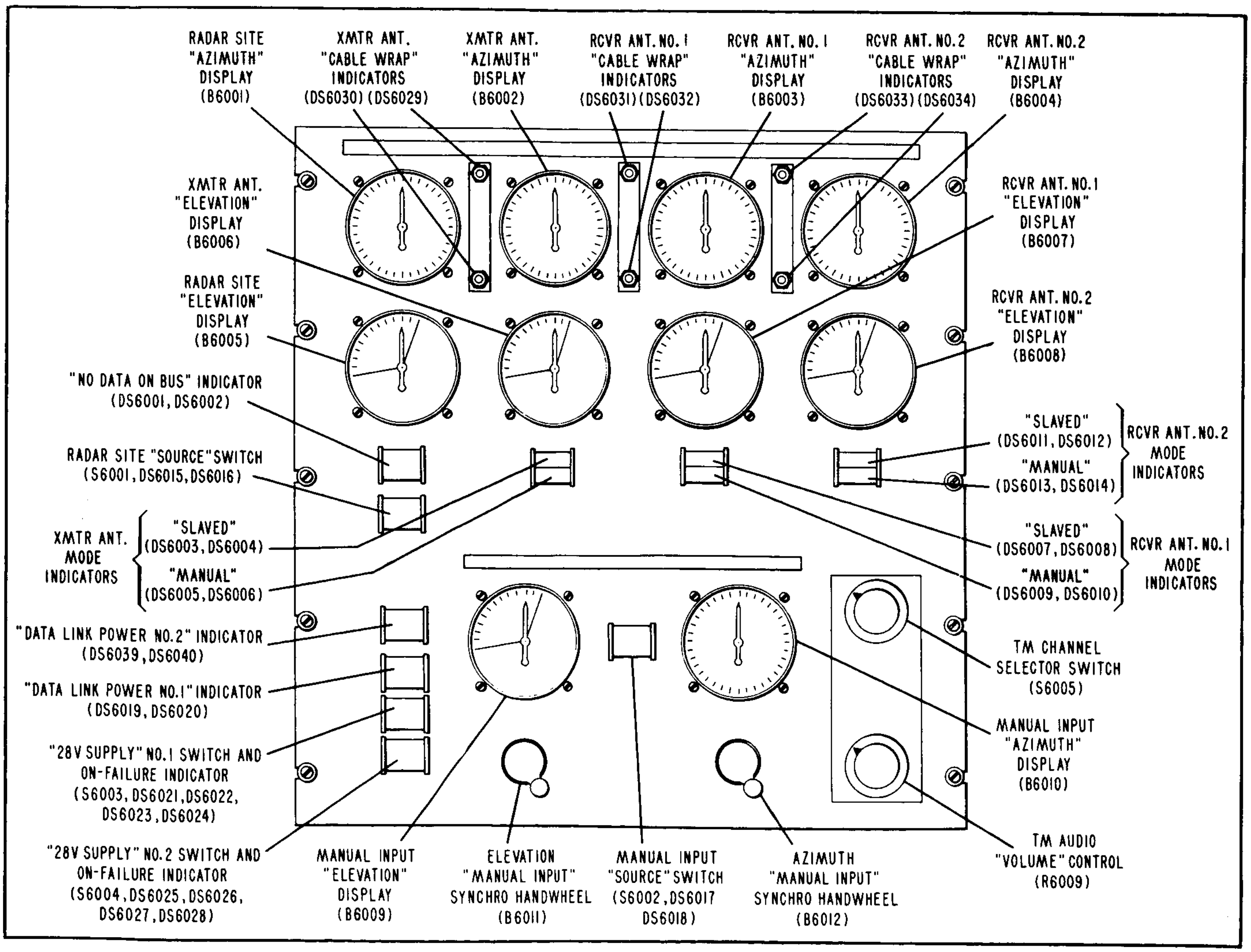


Figure 3-2. Receiver Site Acquisition Data Panel

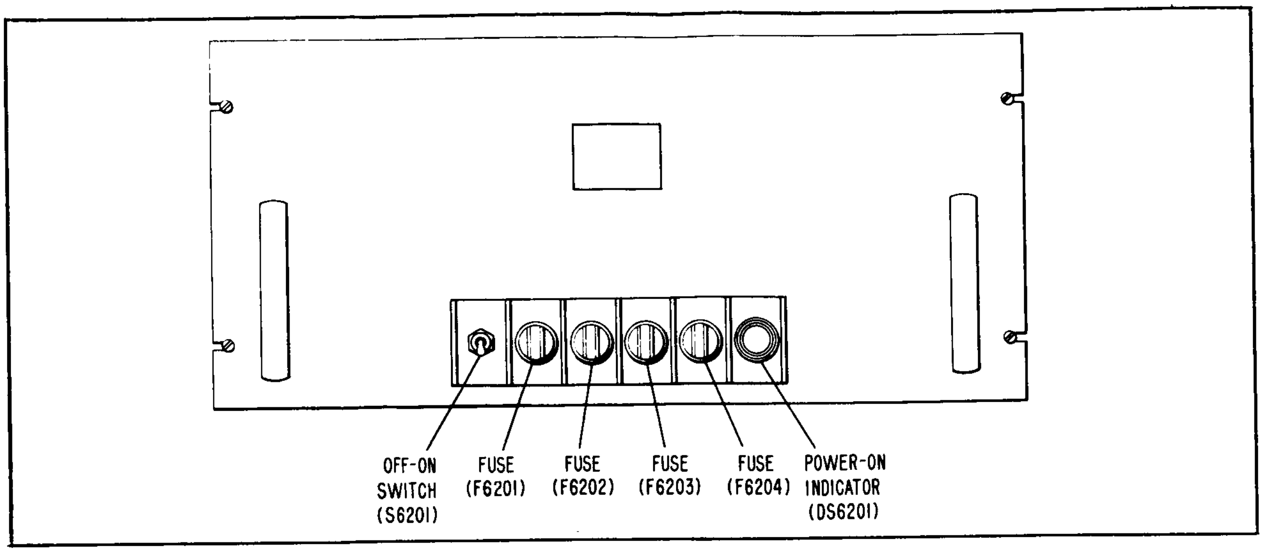


Figure 3-3. Dual Power Supply

(10). Check and, if necessary, adjust the output voltage of power supply number 2 in accordance with the instructions in paragraph 5-4.D.(2).

(11). Depress the "28V SUPPLY" number 1 switch. The on-failure indicators for both power supplies should be green.

C. INDICATORS

(1). Turn on the acquisition data console circuit breaker on the site power panel.

(2). Turn on the OFF-ON switch on the dual power supply panel (figure 3-3).

(3). Depress the "28V SUPPLY" number 1 and number 2 switches on the acquisition data panel (figure 3-1 or 3-2).

(4). Check the operation of each of the console indicators by completing its circuit with a temporary jumper to a 28 VDC source or ground. The indicators to be checked in this manner and the associated terminals to be jumpered to 28 VDC or ground are listed in tables 3-II and 3-III. As each of the indicators is lighted, remove its display screen to see that both color filters are in place and that both lamps are working (except for the cable wrap indicators, which have no color filter and only one lamp).

TABLE 3-II. INDICATOR CHECKOUT PROCEDURE, RADAR SITE

Indicator	Terminal to be Jumpered	Jumper Connection
Active Acquisition Aid "CABLE WRAP" (DS6047)	TB6008-7	28 VDC
Active Acquisition Aid "CABLE WRAP" (DS6048)	TB6008-8	28 VDC
Active Acquisition Aid "AUTO" (DS6001, DS6002)	TB6008-1	28 VDC
Active Acquisition Aid "SLAVED" (DS6003, DS6004)	TB6008-2	28 VDC
Active Acquisition Aid "MANUAL" (DS6005, DS6006)	TB6008-3	Ground
Verlort Radar "VALID TRACK" (DS6010, DS6011)	TB6011-1	Ground
Verlort Radar "SLAVED" (DS6013, DS6014)	TB6011-2	28 VDC
Verlort Radar "MANUAL" (DS6015, DS6016)	TB6011-3	28 VDC
FPS-16 Radar "VALID TRACK" (DS6020, DS6021)	TB6011-7	Ground
FPS-16 Radar "SLAVED" (DS6023, DS6024)	TB6011-8	28 VDC
FPS-16 Radar "MANUAL" DS6025, DS6026)	TB6014-1	28 VDC
Remote Site "SLAVED" (DS6029, DS6030)	TB6014-4	Ground
Remote Site "MANUAL" (DS6031, DS6032)	TB6014-5	Ground
DATA LINK POWER (DS6049, DS6050)	TB6011-5	28 VDC

TABLE 3-III. INDICATOR CHECKOUT PROCEDURE, RECEIVER SITE

Indicator	Terminal to be Jumpered	Jumper Connection
Transmitting Antenna "SLAVED" (DS6003, DS6004)	TB6012-1	Ground
Transmitting Antenna "MANUAL" (DS6005, DS6006)	TB6012-3	Ground
Transmitting Antenna "CABLE WRAP" (DS6029)	TB6012-4	Ground
Transmitting Antenna "CABLE WRAP" (DS6030)	TB6012-6	Ground
Receiving Antenna No. 2 "SLAVED" (DS6011, DS6012)	TB6010-1	28 VDC
Receiving Antenna No. 2 "MANUAL" (DS6013, DS6014)	TB6010-2	28 VDC
Receiving Antenna No. 2 "CABLE WRAP" (DS6033)	TB6010-3	28 VDC
Receiving Antenna No. 2 "CABLE WRAP" (DS6034)	TB6010-4	28 VDC
Receiving Antenna No. 1 "SLAVED" (DS6007, DS6008)	TB6013-1	28 VDC
Receiving Antenna No. 1 "MANUAL" (DS6009, DS6010)	TB6013-3	28 VDC
Receiving Antenna No. 1 "CABLE WRAP" (DS6031)	TB6013-5	28 VDC
Receiving Antenna No. 1 "CABLE WRAP" (DS6032)	TB6013-6	28 VDC
Synchro Remoting System No. 1 "DATA LINK POWER" (DS6019, DS6020)	TB6010-8	28 VDC
Synchro Remoting System No. 2 "DATA LINK POWER" (DS6039, DS6040)	TB6010-6	28 VDC

D. SOURCE SWITCHES - RADAR SITE (Figure 3-1)

(1). Turn on the acquisition data console circuit breaker on the site power panel.

(2). Turn on the OFF-ON switch on the dual power supply panel (figure 3-3) and depress "28V SUPPLY" number 1 and number 2 switches on the acquisition data panel.

(3). The "NO DATA ON BUS" indicator should be lit. Remove the display screen and check that both color filters are in place and that both lamps are lit.

(4). Depress the manual input "SOURCE" switch. The "NO DATA ON BUS" indicator lamps should go out. The switch should remain depressed, and its indicator lamps should light. Check the color filters and lamps with the display screen removed.

(5). Depress the active acquisition aid "SOURCE" switch. The manual input "SOURCE" switch should be de-actuated, and its indicator lamps should go out. The active acquisition aid "SOURCE" switch should remain depressed, and its indicator lamps should light. Check its color filters and lamps with the display screen removed.

(6). Depress the Verlort radar "SOURCE" switch. The active acquisition aid "SOURCE" switch should be de-actuated, and its indicator lamps should go out. The Verlort radar "SOURCE" switch should remain depressed, and its indicator lamps should light. Check its color filters and lamps with the display screen removed.

(7). Depress the FPS-16 radar "SOURCE" switch. The Verlort radar "SOURCE" switch should be de-actuated, and its indicator lamps should go out. The FPS-16 radar "SOURCE" switch should remain depressed, and its indicator lamps should light. Check its color filters and lamps with the display screen removed.

(8). Depress the remote site "SOURCE" switch. The FPS-16 radar "SOURCE" switch should be de-actuated, and its indicator lamps should go out. The remote site "SOURCE" switch should remain depressed, and its indicator lamps should light. Check its color filters and lamps with the display screen removed.

E. SOURCE SWITCHES - RECEIVER SITE (Figure 3-2)

(1). Turn on the acquisition data console circuit breaker on the site power panel.

(2). Turn on the OFF-ON switch on the dual power supply panel (figure 3-3) and depress "28V SUPPLY" number 1 and number 2 switches on the acquisition data panel.

(3). The "NO DATA ON BUS" indicator should be lit. Remove the display screen and check that both color filters are in place and that both lamps are lit.

(4). Depress the manual input "SOURCE" switch. The "NO DATA ON BUS" indicator lamps should go out. The switch should remain depressed, and its indicator lamps should light. Check the color filters and lamps with the display screen removed.

(5). Depress the radar site "SOURCE" switch. The manual input "SOURCE" switch should be de-actuated, and its indicator lamps should go out. The radar site "SOURCE" switch should remain depressed, and its indicator lamps should light. Check its color filters and lamps with the display screen removed.

F. SYNCHROS AND SYNCHRO LINE AMPLIFIERS

There is no convenient means of performing checks on the synchros and synchro line amplifiers without operation of the entire acquisition system and all of the equipment connected to it. Therefore, the initial check of these items should be made during the first system operational check (paragraph 3-5).

G. AUDIO AMPLIFIER

Check the audio amplifier as part of the first system operational check, paragraph 3-5.

H. SIGNAL STRENGTH METERS AND PILOT LIGHTS

As part of the initial turn-on procedure, the meters on the receiver site acquisition data console signal strength meter panel require calibration. Refer to paragraph 5-4.H. for detailed instructions. Proceed as follows to check the operation of the pilot lights on the meter panel:

(1). With the dual power supply on the console turned on, turn TM CHANNEL SELECTOR SWITCH S6005 to the number 1 position. Pilot light DS6035

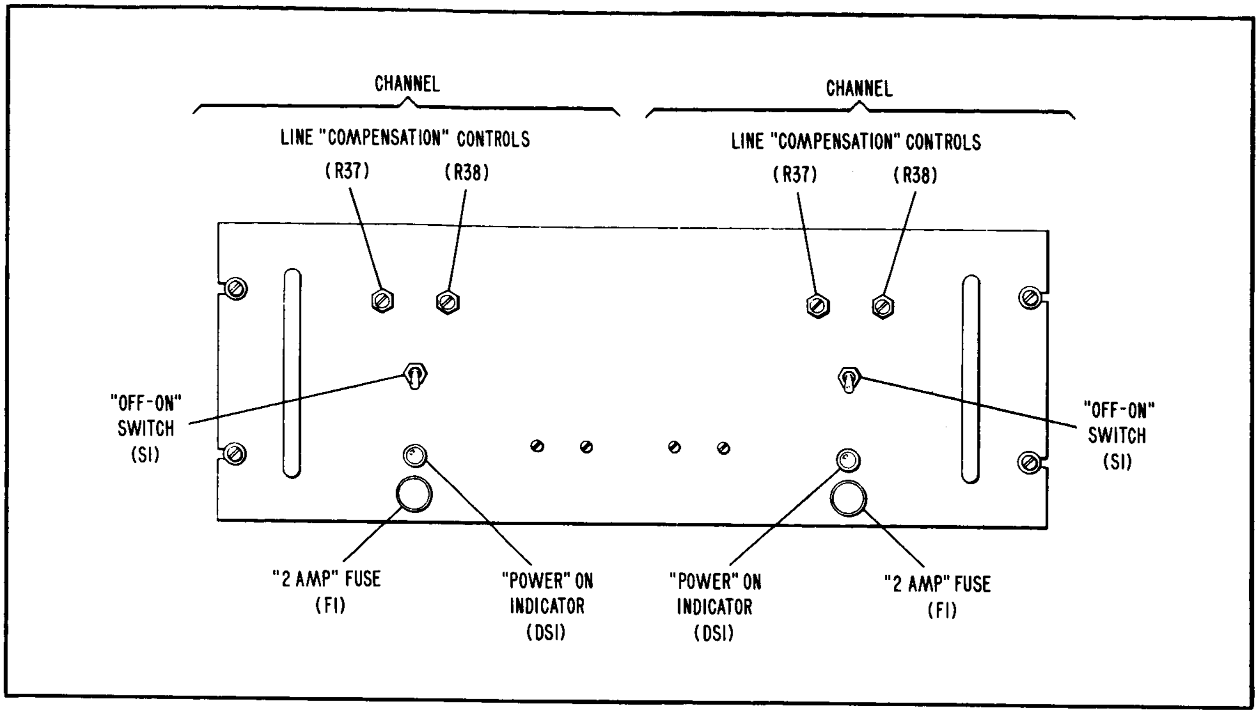


Figure 3-4. Synchro Line Amplifier

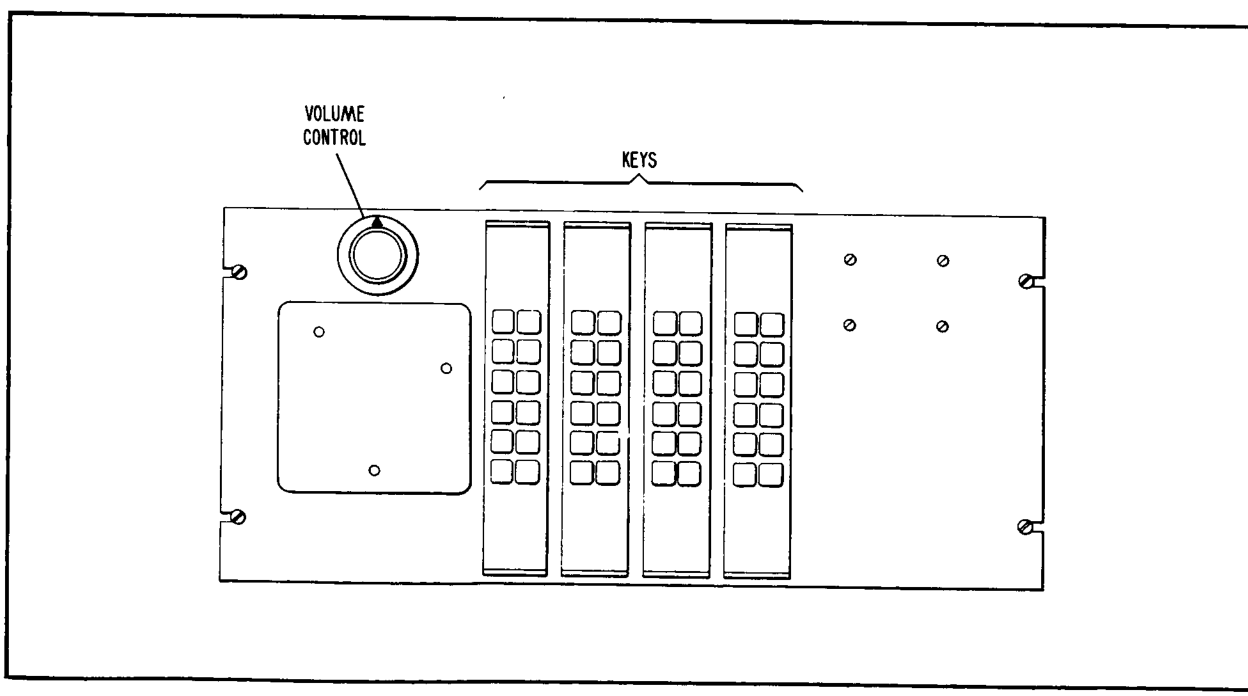


Figure 3-5. Intercom Panel

should light. (See figures 3-2 and 3-6.)

(2). Turn the TM CHANNEL SELECTOR SWITCH to positions 2, 3, and 4. Pilot lights DS6036, DS6037, and DS6038 should light in succession.

I. INTERCOM PANEL

For information on the intercom panel in the radar site acquisition data console and in the intercom cabinet at the receiver site, refer to the Intrasite PBX and Intercom System Manual, MS-109.

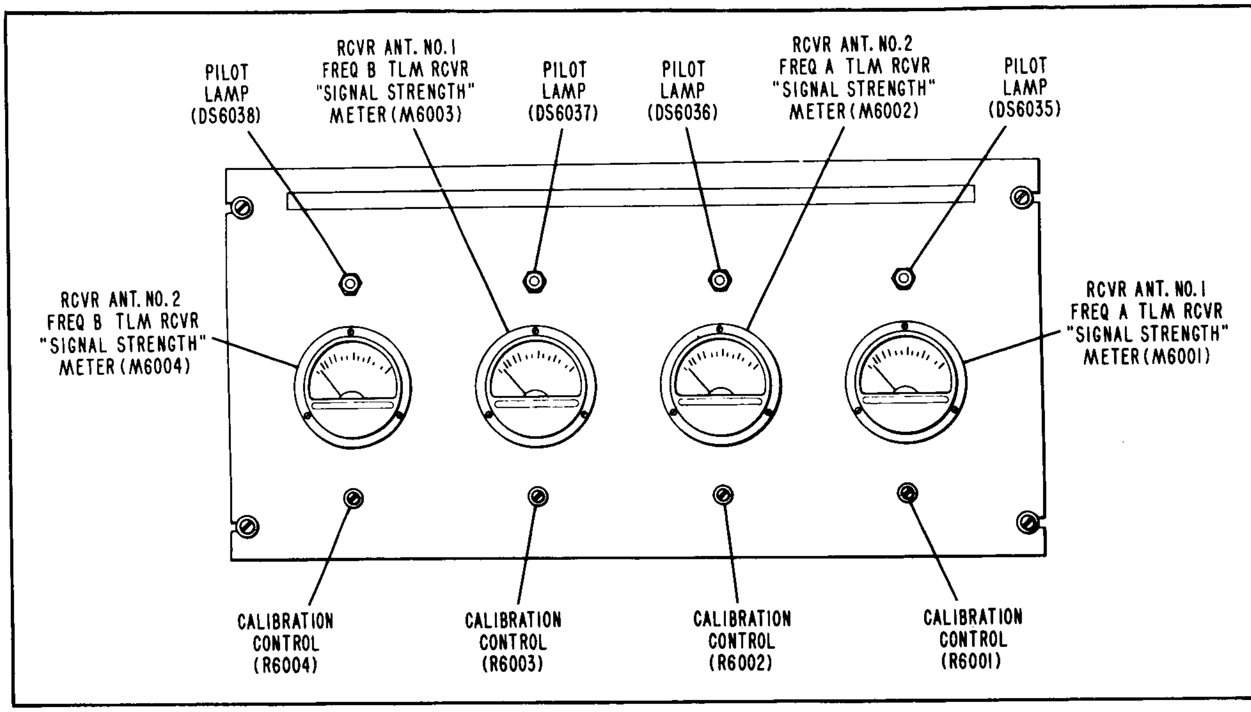


Figure 3-6. Signal Strength Meter Panel

3-3. NORMAL TURN-ON PROCEDURE

A. For normal turn-on procedures for all equipment other than the acquisition data console, see the applicable equipment manuals, listed in table 1-II.

B. For normal turn-on of the acquisition data console, proceed as follows:

(1). Turn on the acquisition data console circuit breaker on the site power panel.

(2). Turn on the OFF-ON switch on the dual power supply panel (figure 3-3).

(3). Depress the "28V SUPPLY" number 1 and number 2 switches (figure 3-1 or 3-2). Both of the associated indicators should come on and should be green. The acquisition data console is now ready for operation.

3-4. NORMAL OPERATING PROCEDURE

Paragraphs 3-4.A. (radar site) and 3-4.B. (receiver site) present operating instructions for the acquisition system without specifying when and under what conditions the various functions are to be performed. The latter information is given in paragraphs 3-4.C. and 3-4.D.

A. OPERATING INSTRUCTIONS - RADAR SITE

(1). Turn on the acquisition data console in accordance with paragraph 3-3.

(2). Turn on synchro line amplifiers number 1 and number 2 (on the acquisition data console) by turning on all of the channel "OFF-ON" switches. The "POWER ON" indicators should come on. (See figure 3-4.)

(3). By intercom, instruct the operator at the Verlort radar to turn on the synchro line amplifier there (number 3).

(4). Turn on the synchro remoting system transmitter-receiver (refer to the applicable equipment manual, listed in table 1-II).

(5). If the manual input is to be used, set the handwheels (figure 3-1) so that the associated displays are at the desired azimuth and elevation.

(6). By intercom, instruct the operators of the active acquisition aid, FPS-16 radar, Verlort radar, and receiver site acquisition data console to disconnect their equipment from the radar site acquisition bus and stand by for further instructions.

(7). Check the d-c mode indications from the receiver site to see that the console there is in the manual mode of operation. The active acquisition aid and the two radars should be in the manual or automatic mode.

CAUTION

The purpose of disconnecting equipment from the acquisition bus before switching data on is to avoid sudden, large changes in the inputs to the antenna positioning systems. Such step-function inputs impose unnecessary wear on the equipment, and under certain circumstances can drive the antennas into their azimuth or elevation limit stops.

(8). Connect the desired source of data (manual, active acquisition aid, Verlort, or FPS-16) to the acquisition bus by depressing the proper "SOURCE" switch (figure 3-1). The source switch indicator should light and the switch should remain depressed after being released. The "NO DATA ON BUS" indicator should go out.

(9). By intercom, instruct the operators of the receiver site console and all antennas which are not the source of the data on the bus to set their antennas to the approximate azimuth and elevation which have been connected to the bus. The azimuth and elevation data connected to the bus is shown on the console displays of the selected source (figure 3-1).

(10). Check the position of the antennas on the console displays and then instruct the operators that they may slave their antennas to the acquisition bus. (Table 3-IV gives the name, location, and proper position or condition of the various controls used for selecting the operating modes of the various pieces of equipment in or connected to the acquisition system.)

CAUTION

Be sure that the positions of the active acquisition aid and receiver site antennas are correct before they are slaved to the acquisition bus. Otherwise, one or more of them may be driven into its azimuth or elevation limit stops.

(11). Check the d-c mode indicators to see that the receiver site console is slaved to the radar site acquisition bus. If the active acquisition aid or one of the radars has been selected as the source of data for the acquisition bus, it cannot be slaved to the bus. If the manual input has been selected as the source of data, slaving of the active acquisition aid to the bus is at the option of the active acquisition aid operator, and slaving of the radars to the bus is at the option of the radar operators.

(12). If the active acquisition aid is slaved to the bus, check the console displays from it to see that it is in the proper location in regard to its cable wrap limits. The upper "CABLE WRAP" indicator should be lit if the pointer of the associated "AZIMUTH" display is in the upper half of the dial, and the lower indicator should be lit if the pointer is in the bottom half of the dial. (Refer to paragraph 4-2.B.(4). and figure 4-7 for complete information on antenna position relative to cable wrap limits.)

(13). Check the system slaving accuracy: The console displays of data from the slaved antennas (active acquisition aid and radars) should not differ by more than 1.5 degrees from the console displays of data from the selected source. The display of data from the receiver site should not differ by more than 3 degrees from the selected source display.

(14). To change from one source of acquisition bus data to another, proceed as follows:

(a). Check the azimuth displays of the two data sources (the one to be switched off the bus and the one to be switched onto the bus) to see that switching from one to the other will not drive the slaved antennas into their limit stops. Synchro devices and servo systems using them always turn in the direction which results in the lesser amount of rotation in turning to a new, switched-in position; when a synchro receiver is switched to a transmitter with a position different from that of the receiver, the receiver always turns 180 degrees or less—never more than 180 degrees. Thus, if a limit lies between the positions of the slaved antennas and the new source in the direction of lesser rotation, switching to the new source will drive the slaved antennas into their limits. When this circumstance exists, follow the procedure below before switching:

1. If manual input data is to be switched onto the bus (data from the active acquisition aid or one of the radars is on the bus and is to be switched off): Turn the manual input to approximately the same position as the data already on the bus.

2. If active acquisition aid or radar data is to be switched onto the bus (manual input data is on the bus and is to be switched off): Turn the manual input (and the antennas slaved to it) to the approximate position of the new source (active acquisition aid or one of the radars). If the new source is the active acquisition

aid, turn the manual input in the direction which results in the slaved antennas being in the same position relative to their cable wrap limits as is the active acquisition aid antenna.

3. If data from the active acquisition aid, the Verlort, or the FPS-16, is on the bus, and data from another source is to be connected to the bus, connect the manual input to the bus in accordance with step 1. above. Then turn the manual input to the new source in accordance with step 2. This procedure brings the slaved antennas smoothly from the position of the old source to that of the new source without having to change the position of either source.

(b). Connect the new source of data to the acquisition bus by depressing the appropriate "SOURCE" switch. This action also disconnects the previous source.

(c). If manual data has been switched onto the bus, but the manual input has been turned away from the desired position per step (a). 1., set the manual input to the desired position.

(d). Check the condition of cable wrap and system slaving accuracy as directed in preceding steps (12) and (13).

B. OPERATING INSTRUCTIONS - RECEIVER SITE

(1). Turn on the acquisition data console in accordance with the instructions in paragraph 3-3.

(2). Turn on the audio amplifier on the console by turning on "OFF-ON" switch S2 (figure 3-7).

(3). Turn on the synchro line amplifier (on the acquisition data console) by turning on both of the channel "OFF-ON" switches. The "POWER ON" indicators should come on. (See figure 3-4.)

(4). By intercom, instruct the operator at the transmitting antenna to turn on the synchro line amplifier there.

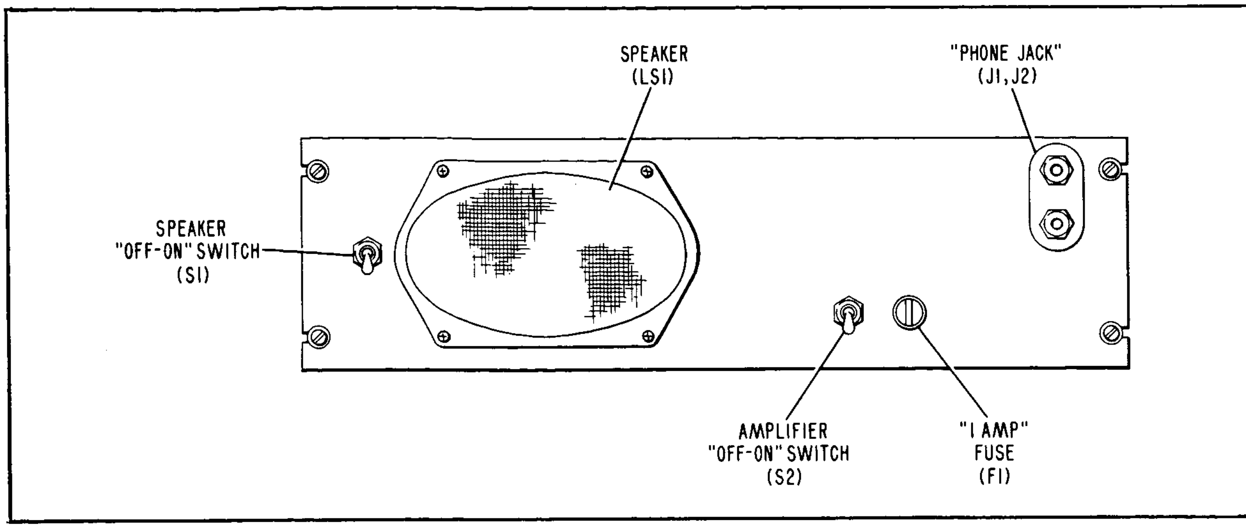


Figure 3-7. Audio Amplifier

(5). Turn on the transmitter-receivers of synchro remoting systems number 1 and 2 and instruct the operator at the transmitter site to turn on the transmitter-receiver there. (Refer to the applicable equipment manual, listed in table 1-II.)

(6). Set the manual input on the acquisition data console to any convenient position and instruct the operators of the two receiving antennas and the transmitting antenna to set their antennas to the position of the manual input.

(7). Connect the manual input to the acquisition bus by depressing the manual input "SOURCE" switch.

(8). Check the position of the receiving and transmitting antennas on the console displays to see that they are approximately the same as the manual input and instruct the operators to slave their antennas to the acquisition bus. (Table 3-IV gives the name location, and proper position or condition of the various controls used for selecting the operating modes of the receiving and transmitting antennas.)

CAUTION

Be sure that the positions of the receiving and transmitting antennas are correct before they are slaved to the acquisition bus. Otherwise, one or more of them may be driven into its azimuth or elevation limit stops.

(9). Check the d-c mode indicators to see that the receiving and transmitting antennas are slaved to the acquisition bus.

(10). Check the console displays from the antennas to see that each of them is in the proper location in regard to its cable wrap limits. The upper "CABLE WRAP" indicator should be lit if the pointer of the associated "AZIMUTH" display is in the upper half of the dial, and the lower indicator should be lit if the pointer is in the lower half of the dial. (Refer to paragraph 4-2.B.(4). and figure 4-7 for complete information on antenna position relative to cable wrap limits.)

(11). Check the system slaving accuracy: The console displays of data from the slaved antennas should not differ by more than 3 degrees from the console displays of data from the selected source.

(12). When instructed to do so by the radar site acquisition data console operator, turn the manual input to the same position as the data on the radar site acquisition bus (as noted on the receiver site console displays) and connect the receiver site bus to the radar site bus by depressing the radar site "SOURCE" switch (figure 3-2). Since the receiving and transmitting antennas are already slaved to the receiver site bus, this action slaves these antennas to the data connected to the bus at the radar site acquisition data console.

(13). For normal operation, no other action is required on the part of the receiver site acquisition data console operator except to monitor the displays and indicators on the console for indications of improper operation of the system. However, be prepared at any time to switch for emergency operation from the slaved mode to manual in order to point the receiving and transmitting antennas in accordance with signal strength indications. To operate with signal strength indications proceed as follows:

(a). Set the manual input to the azimuth and elevation at which the capsule is known or expected to be and connect this data to the acquisition bus by depressing the manual input "SOURCE" switch.

(b). With the transmitting and receiving antennas slaved to the acquisition bus, turn TM CHANNEL SELECTOR SWITCH S6005 on the console acquisition data panel (figure 3-2) to the channel which provides the strongest and clearest signal strength indication and audio.

(c). Adjust telemetry audio "VOLUME" control R6009 on the acquisition data panel for a clearly audible signal.

(d). Continually adjust the manual input handwheels to keep the selected signal strength indication as nearly as possible at a maximum. This action keeps the transmitting and receiving antennas pointed at the capsule. In addition to being supplied to the receiver site acquisition data console, display data from receiving antenna number 1 is also supplied to the radar site console, where at the option of the radar site console operator it may be connected to the radar site acquisition bus.

C. OPERATING CRITERIA - RADAR SITE

Paragraph A has described how to perform various functions in the operation of the acquisition system. This paragraph describes when and under what conditions the functions are to be performed.

(1). PREPARATION FOR CAPSULE PASS

(a). Perform the system operational checks described in paragraph 3-5.

(b). Set the acquisition data console manual input in accordance with predicted data.

(c). Connect the manual input to the acquisition bus and notify the appropriate operators to slave all antennas to the bus.

(2). INITIAL ACQUISITION - ACTIVE ACQUISITION AID

(a). In the Mercury capsule there are two telemetry transmitters which operate at different frequencies in the 225- to 260-megacycle band. The transmitters operate at the same power, and normally either frequency may be used in tracking the capsule. Therefore, for initial acquisition and subsequent tracking, the active acquisition aid may be set at either frequency unless difficulty in acquisition and tracking is encountered. If difficulty is encountered, try the other frequency to see if better results are obtained.

(b). Watch the signal strength indicators and panalyzer and listen

TABLE 3-IV. MODE INDICATING CONTROLS

Equipment	Mode	Name of Control	Location	Position
Active Acquisition Aid	Manual	"MANUAL" switch	Control Console Mode Switch Panel	Depressed
	Slaved	"SLAVED" switch	Control Console Mode Switch Panel	Depressed
	Automatic	"AUTO" switch	Control Console Mode Switch Panel	Depressed
FPS-16 Radar (Note 1)	Manual	"MANUAL MODE" pushbutton	Range Indicator Panel, Radar Console	Depressed
	Automatic	"DATA ACCEPTABLE-YES" pushbutton	Range Indicator Panel, Radar Console	Depressed
	Slaved	"DESIGNATION DATA SOURCE 1" pushbutton	Range Indicator Panel, Radar Console	Depressed
Verlort Radar	Manual	"MANUAL" pushbutton	Mode Control Panel, Radar Console	Depressed
	Automatic	"DATA ACCEPTABLE" switch	Range and Aided Control Panel, Radar Console	"ON"
	Slaved	"REMOTE POSITION SELECTOR" switch	Mode Control Panel, Radar Console	Position "3"
		"REMOTE" pushbutton	Mode Control Panel, Radar Console	Depressed
Receiving Antenna No. 1	Manual	"ELEVATION LOCAL-REMOTE" switch	Servo Rack Control Indicator Unit	"LOCAL"
		"AZIMUTH LOCAL-REMOTE" switch	Servo Rack Control Indicator Unit	"LOCAL"
	Slaved (Note 2)	"ELEVATION LOCAL-REMOTE" switch	Servo Rack Control Indicator Unit	"REMOTE"
		"AZIMUTH LOCAL-REMOTE" switch	Servo Rack Control Indicator Unit	"REMOTE"
Receiving Antenna No. 2	Manual	"ELEVATION LOCAL-REMOTE" switch	Servo Rack Control Indicator Unit	"LOCAL"
		"AZIMUTH LOCAL-REMOTE" switch	Servo Rack Control Indicator Unit	"LOCAL"

TABLE 3-IV. MODE INDICATING CONTROLS (Cont.)

Equipment	Mode	Name of Control	Location	Position
	Slaved (Note 2)	"ELEVATION LOCAL-REMOTE" switch	Servo Rack Control Indicator Unit	"REMOTE"
		"AZIMUTH LOCAL-REMOTE" switch	Servo Rack Control Indicator Unit	"REMOTE"
Transmitting Antenna	Manual	"ELEVATION LOCAL-REMOTE" switch	Servo Rack Control Indicator Unit	"LOCAL"
		"AZIMUTH LOCAL-REMOTE" switch	Servo Rack Control Indicator Unit	"LOCAL"
	Slaved (Note 2)	"ELEVATION LOCAL-REMOTE" switch	Servo Rack Control Indicator Unit	"REMOTE"
		"AZIMUTH LOCAL-REMOTE" switch	Servo Rack Control Indicator Unit	"REMOTE"

Notes: 1. The mode indications from the FPS-16 are controlled by circuits in the IRACQ console as well as by the controls given in this table. The IRACQ console circuits are beyond the scope of this manual.

2. For a "SLAVED" indication on the acquisition data console, both switches must be in the remote position. Otherwise, a "MANUAL" indication is given.

for telemetry audio. These will be the first indications that the capsule is in range.

(c). As soon as there are indications that a signal is being received, switch the active acquisition aid into automatic tracking and closely monitor its action as shown on the control console synchro displays.

(d). At low elevation angles the active acquisition aid may track a signal reflected from the ground. Therefore, closely monitor the control console synchro displays, particularly the elevation display. If the indicated elevation angle goes below the known horizon, switch to the manual elevation mode and position the antenna for minimum elevation error signal indication at an elevation above the horizon. Manually track the capsule in elevation until it is a few degrees higher above the horizon and then switch back to fully automatic tracking. (Both channels in automatic.)

(e). By intercom, keep the acquisition data console operator informed of the status of tracking with the active acquisition aid. This status information is especially important during the critical, initial acquisition phase of the operation. As soon as fully automatic tracking is achieved and the quality of the track is verified by observation of the synchro displays, notify the acquisition data console operator of this fact in order to confirm the "AUTO" d-c mode indication (which was given when the active acquisition aid was switched into automatic).

(3). INITIAL ACQUISITION - VERLORT RADAR

The Verlort radar should remain slaved to the acquisition bus until a capsule signal is received by the active acquisition aid (unless of course the radar should locate the capsule before the active acquisition aid does). When a capsule signal is received by the active acquisition aid at a low elevation angle, the elevation channel of the Verlort should be switched from the slaved mode, and elevation searching begun. The azimuth channel of the radar should remain slaved to the active acquisition aid (through the acquisition bus) and elevation searching should be continued until the radar acquires the capsule or until the elevation of the capsule is sufficient to insure accurate tracking by the active acquisition aid (at least 10 and preferably 15 degrees above the horizon). If this elevation is reached before the radar acquires the capsule, the elevation channel of the radar should be switched from the searching mode and again be slaved to the active acquisition aid until the capsule is acquired. If the FPS-16 radar acquires the capsule before the Verlort does, data from the FPS-16 will be switched onto the acquisition bus. Both channels of the Verlort should then be slaved through the acquisition bus to the FPS-16.

(4). <u>INITIAL ACQUISITION - FPS-16 RADAR</u>

Procedures for initial acquisition with the FPS-16 are the same as those for the Verlort, described in the preceding paragraph, except of course that if the Verlort acquires the capsule before the FPS-16 does, both channels of the FPS-16 should then be slaved through the acquisition bus to the Verlort radar.

(5). <u>INITIAL ACQUISITION - ACQUISITION DATA CONSOLE</u>

(a). As soon as notification is received from the active acquisition aid (by d-c mode indication or verbal communication) that it is tracking the capsule either automatically, manually by means of the error signal indicators, or manually with signal strength indication, switch the active acquisition aid data onto the acquisition bus. Data from the active acquisition aid when it is tracking in any of these modes is generally more accurate than the manual input settings on the acquisition data console.

(b). After one of the radars has acquired the capsule and is tracking it automatically, switch data from that radar onto the acquisition bus. Data from either radar is preferred to that from the active acquisition aid. When both radars are tracking the capsule automatically, switch data from the FPS-16 onto the bus as FPS-16 data is generally more accurate than the Verlort radar data.

(c). If neither of the radars has acquired the capsule and the active acquisition aid is receiving no indication of capsule telemetry signals, at a time when the capsule should be in range, ask the receiver site acquisition data console operator by intercom whether capsule telemetry signals are being received there. If they are, instruct the receiver site operator to begin positioning the antennas there in accordance with signal strength indications. Connect data from the receiver site to the acquisition bus by depressing the REMOTE SITE "SOURCE" switch. Instruct the active acquisition aid and radar operators to slave their equipment to the acquisition bus and then proceed as in steps (a) and (b) above.

(6). TRACKING

(a). Even after either of the radars acquires the capsule and is in the fully automatic tracking mode, continue to track the capsule with the active acquisition aid so that data will be available to the radar for re-acquisition if tracking is lost before the capsule is out of range.

(b). Should the active acquisition aid lose the track, (radar still tracking automatically) switch the active acquisition aid to the acquisition bus (thus picking up the radar data) until the active acquisition aid re-acquires the capsule. Should both the radars and the active acquisition aid lose the capsule, connect signal strength indication pointing data from the receiver site to the acquisition bus and proceed per paragraph 3-4.C.(5).(c). If data from the receiver site is not available, proceed as follows:

1. Switch acquisition data console manual input data onto the bus.

2. Set the manual input to the best position (estimated or in accordance with predicted data if available) for re-acquisition.

3. As soon as the active acquisition aid or one of the radars re-acquires the capsule, switch data from it onto the acquisition bus.

D. OPERATING CRITERIA - RECEIVER SITE

Paragraph B has described how to perform various functions in the operation of the acquisition system. This paragraph describes when and under what conditions the functions are to be performed.

(1). PREPARATION FOR CAPSULE PASS

(a). Perform the system operational checks described in paragraph 3-5.

(b). Have the transmitting and receiving antennas slaved to the acquisition bus and connect the manual input to the bus at the receiver site console.

(c). When instructed to do so by the radar site console operator, connect data from the radar site to the receiver site bus.

(2). INITIAL ACQUISITION AND TRACKING

For initial acquisition and tracking, data from the radar site normally should remain connected to the receiver site acquisition bus. However, stand by to begin pointing the antennas in accordance with signal strength indications if requested to do so by the radar site console operator.

3-5. SYSTEM OPERATIONAL CHECKS

This paragraph describes the checks to be performed to ascertain that the acquisition data consoles and the overall acquisition system are in satisfactory operating condition. Detailed procedures for equipment other than the acquisition data consoles are given in the applicable individual equipment manuals. All of the checks for each individual piece of equipment and for the overall system are to be performed after initial turn-on of the equipment and again shortly before each Mercury operation. Only the operations to be performed are described in this paragraph. For detailed instructions on how to carry out the operations, see paragraph 3-4.

A. D-C INDICATIONS

(1). RADAR SITE

(a). Check the console 28 VDC power supply and source switches in accordance with the instructions in paragraphs 3-2. B. and D.

(b). Direct the operators of the active acquisition aid, the Verlort radar, and the FPS-16 radar to switch their equipment successively to all modes of operation; "AUTO", "SLAVED" and "MANUAL" for the active acquisition aid and "VALID TRACK", "SLAVED" and

"MANUAL" for the radars. The equipment controls which give these indications are listed in table 3-IV. Also direct the receiver site acquisition data console operator to switch to slaved and manual operation (depress the manual input and radar site "SOURCE" switches). As the equipment and receiver site console operating modes are switched, check the appropriate radar site console d-c mode indicators (figure 3-1) to see that they light when they should. While each indicator is lit, remove the display screen and see that both color filters are in place and that both lamps are lit.

(c). As the active acquisition aid is switched through its operating modes, direct the operators of the two radars to check the indications in the radars from the active acquisition aid. These are "AUTO" and "MANUAL." With no equipment slaved to the acquisition bus, depress successively the active acquisition aid and manual "SOURCE" switches on the console. Direct the radar operators to check the acquisition bus data indicators in the radars ("AAA" and "MANUAL"). As each radar is switched through its operating modes, direct the operator of each radar to check the "VALID TRACK" indication from the other.

(d). Direct the operator of the active acquisition aid to set his antennas to approximately 260 degrees azimuth and then slowly rotate it in the clockwise (increasing azimuth) direction. As the antenna passes 270 degrees, the associated upper (clockwise indicating) cable wrap indicator on the acquisition data console should light. Direct the operator to set the antenna at approximately 280 degrees and then slowly rotate it in the counterclockwise (decreasing azimuth) direction. As the antenna passes 270 degrees, the associated lower cable wrap indicator should light.

(2). RECEIVER SITE

(a). Check the console 28 VDC power supply and source switches in accordance with the instructions in paragraph 3-2.B. and E.

(b). Direct the operators of the transmitting and receiving antennas to switch their equipment successively to "SLAVED" and "MANUAL" operation. The equipment controls which give these indications are listed in table 3-IV. As the operating modes are switched check the appropriate console d-c mode indicators (figure 3-2) to see that they light when they should. While each indicator is lit, remove the display screen and see that both color filters are in place and that both lamps are lit.

(c). Direct the operators of the transmitting and receiving antennas to set their antennas to approximately 260 degrees azimuth and then slowly rotate them in the clockwise (increasing azimuth) direction. As each antenna passes 270 degrees, the associated upper (clockwise indicating) cable wrap indicator on the acquisition data console should light. Direct the operators to set the antennas at approximately 280 degrees and then slowly rotate them in the counterclockwise (decreasing azimuth) direction. As each antenna passes 270 degrees, the associated lower cable wrap indicator should light.

B. SYNCHROS, SYNCHRO LINE AMPLIFIERS, AND SYNCHRO REMOTING SYSTEMS

(1). RADAR SITE

(a). Set the acquisition data console manual inputs to zero degrees azimuth and elevation and switch this data onto the acquisition bus.

(b). Direct the operators of the active acquisition aid and the radars to slave their equipment to the acquisition bus.

(c). Direct the operator of the receiver site acquisition data console to have receiving antenna number 1 slaved to the bus at the receiver site and connect data from the radar site to the receiver site bus.

(d). Check the displays of antenna position (including that from the receiver site) on the radar site console and have the other equipment operators check their local displays. The radar and active acquisition aid antenna position displays (local and on the radar site console) should agree with the manual input displays within ±1.5 degrees. The receiver site displays should agree with the radar site manual input displays within ±3.0 degrees. (The receiver site displays include those at receiving antenna number 1, displays from this antenna on the receiver site console, and displays from the radar site on the receiver site console.)

(e). With the acquisition data console handwheel change the azimuth manual input from zero to 360 degrees in 30-degree steps and change the elevation manual input from zero to 90 degrees, also in 30-degree steps. At each step in azimuth and elevation check the antenna position displays for agreement with the manual input displays as in the preceding paragraph.

(f). With at least one antenna (radar or active acquisition aid) slaved to the bus (only one is necessary for the balance of these checks), switch data in turn from each of the remaining four sources onto the acquisition bus. The remaining four sources are the active acquisition aid, the Verlort radar, the FPS-16 radar, and the receiver site. As each source is connected to the bus, have the operator at the source manually vary the source through 360 degrees in azimuth and 90 degrees in elevation. At each 30-degree step in azimuth and elevation check the console displays from the source and from the slaved antenna. The console displays should agree with the source data displays at the source within ±1.5 degrees except when the receiver site is the source. In the latter case the console displays should agree with the display at the source within ±3.0 degrees.

(2). RECEIVER SITE

(a). Set the acquisition data console manual inputs to zero degrees azimuth and elevation and switch this data onto the acquisition bus.

(b). Direct the operators of the transmitting and receiving antennas to slave their equipment to the acquisition bus.

(c). Check the displays of antenna position on the receiver site console and have the other equipment operators check their local displays. All displays should agree with the console manual input displays within ± 3.0 degrees.

(d). With the acquisition data console handwheel change the azimuth manual input from zero to 360 degrees in 30-degree steps and change the elevation manual input from zero to 90 degrees, also in 30-degree steps. At each step in azimuth and elevation check the antenna position displays for agreement with the manual input displays as in the preceding paragraph.

C. SIGNAL STRENGTH METERS

Check the calibration of the meters on the receiver site acquisition data console signal strength meter panel in accordance with the instructions in paragraph 5-4.H.

D. AUDIO AMPLIFIER

With an r-f signal generator connected to the telemetry receivers in the same manner as for signal strength calibration (refer to paragraph 5-4.H.), set the signal generator output level to 100 microvolts with audio modulation. This signal into the telemetry receivers should provide a clearly audible output from the acquisition data console audio amplifier, both through the speaker and into a headset. Check each telemetry channel in this manner.

3-6. EMERGENCY OPERATING PROCEDURE

Emergency operation of the acquisition system will be required under two general conditions. The first of these conditions is the unavailability of data from a source when it normally should be available. This unavailability could be due either to a malfunction of the source equipment or to simple failure to acquire the capsule. The second condition requiring emergency operation is a malfunction of a component, such as a synchro remoting system or a synchro line amplifier, which does not directly affect a data source but which hinders or prevents communication or transmission of data. Procedures for operation under these two general conditions are discussed in the following paragraphs.

A. OPERATION WITH DATA SOURCE FAILURE

The procedure for operating when data from the normal source is not available is simply to use the next best data which is available. The order of preference of data sources at the radar site and the receiver site is as follows:

(1). RADAR SITE

(a). FPS-16 radar in fully automatic tracking.

(b). Verlort radar in fully automatic tracking.

(c). Active acquisition aid in fully automatic tracking.

(d). Active acquisition aid in manual tracking by error signal indication in one channel, automatic tracking in the other.

(e). FPS-16 radar in semi-automatic tracking (one channel automatic, the other manual).

(f). Verlort Radar in semi-automatic tracking (one channel automatic, the other manual).

(g). Active acquisition aid in manual tracking by error signal indication in both channels.

(h). Pointing data by means of signal strength indications from the receiver site.

(i). Manual input at the acquisition data console.

(j). Independent manual positioning of antennas in accordance with tracking data read over the intercom system. This manner of operation would apply to the active acquisition aid or a radar if its connection to the acquisition bus was broken, but other equipment was operative and tracking the capsule.

(k). Independent manual positioning of antennas in accordance with predicted data.

(2). RECEIVER SITE

(a). Data from the radar site originating from any of the sources given in (a) through (g) of the previous paragraph.

(b). Manual input in accordance with signal strength indications.

(c). Manual input in accordance with predicted data.

(d). Independent manual positioning of antennas in accordance with data read over the intercom.

B. OPERATION WITH COMPONENT MALFUNCTION

In many instances if a component fails and cannot be repaired or replaced in the time available, temporary circuit connections can be made which will allow at least limited operation of the system. It is of course impractical to attempt to give specific instructions covering all possible failures; maintenance personnel must have sufficient knowledge of the system to devise temporary fixes on the spot. However, to illustrate the types of fixes that might be used, some examples are given in the following paragraphs.

(1). ACQUISITION DATA CONSOLE 28 VDC POWER SUPPLY

(a). Each of the two 28 VDC power supplies in the acquisition data consoles is capable of easily supplying all of the current needed in the console and 28-volt devices connected to it. Therefore, failure of one supply reduces the reliability of the console, but does not make it inoperative.

(b). Should both of the console 28-volt supplies fail, 28 VDC can be supplied to the console from other, nearby equipment: Turn off the dual power supply OFF-ON switch (figure 3-3) and check the console 28 VDC bus to see that it is not shorted to ground. Jumper any convenient terminal on the console 28 VDC bus (see figure 7-1 or 7-3) to a source in other equipment which can supply about one ampere in addition to its normal load. Also connect a jumper between acquisition data console ground and the negative side of the external 28-volt supply. The acquisition data console can now be operated normally except for turning 28 VDC off and on.

(2). RELAYS

Defective relays can be "fixed" by jumpering the normally open terminals. For instance, should the radar site acquisition data console relay (K6005) which connects data from the active acquisition aid to the acquisition bus fail, data from the active acquisition aid can be connected to the bus by placing jumpers between terminal boards TB6007 and TB6009. (See figure 7-1.)

(3). SYNCHRO LINE AMPLIFIERS

A malfunctioning synchro line amplifier in a critical location in the system, such as in the acquisition bus, can be replaced by another amplifier from a less critical place, such as a display data circuit. Also, synchro line amplifiers can temporarily be "fixed" by removing them from the circuit and jumpering their inputs to the corresponding outputs. However, this action will introduce a 180-degree phase reversal, and the synchro circuit will have to be adjusted accordingly. Refer to paragraph 5-4.B.

(4). SYNCHROS

Like synchro line amplifiers, a defective synchro in a critical place can be replaced by another synchro from a less critical place. For example, if one of the azimuth or elevation manual input synchro receivers on the receiver site acquisition data console fails, it can be replaced by the receiving or transmitting antenna azimuth or elevation display synchro receiver on the console.

SECTION IV
THEORY OF OPERATION

4-1. GENERAL

With the exception of the acquisition data consoles, which are treated in detail, this section presents the theory of operation of the acquisition system on a block diagram level. Adjoining systems, those which receive information from or supply information to the acquisition system, are treated only to the extent of their interconnections with the acquisition system. For further information on these systems, see the applicable system manuals. For detailed information on the acquisition system components which are described only on a block diagram level, see the applicable equipment manuals. These manuals are listed in table 1-II.

A. FUNCTION OF THE SYSTEM

As was described in Section I, the function of the acquisition system is to take the best data available on the capsule's azimuth and elevation at any given time and make it available on the acquisition bus for use by the active acquisition aid, the receiving antennas, the transmitting antenna, and the radars. (The acquisition bus is the "common" line which distributes data to the using equipment.) The active acquisition aid and the radars use the data from the acquisition bus as an aid in acquiring the capsule for automatic tracking. As soon as they begin automatic tracking, the active acquisition aid and the radars stop using data from the acquisition bus; however, under most conditions during a pass, acquisition data is still available to the active acquisition aid and the radars for use in re-acquiring the capsule in case they lose automatic tracking before the capsule is out of tracking range. The transmitting and receiving antennas and their associated equipment cannot track a target automatically. Therefore, these antennas are normally slaved to data from from the acquisition system at all times during a pass.

B. DATA INPUTS

(1). RADAR SITE

Data inputs to the acquisition system at the radar site are available from five sources: manual input, active acquisition aid, Verlort radar, FPS-16 radar, and the receiver site. At the acquisition data console data from the best (most accurate) of these five sources is switched onto the acquisition bus and thereby made available to all of the steerable antennas on the site (except the one, if any, which is the source of the data on the bus).

(a). The manual input to the acquisition system at the radar site is made with synchro transmitters on the acquisition data console. These synchros are positioned by means of handwheels in accordance with predicted capsule azimuth and elevation data based on computations of the capsule's orbit.

(b). Data from the active acquisition aid, the Verlort radar, and the FPS-16 radar is taken from synchro transmitters which are mechanically coupled to the antennas of these pieces of equipment. The connection of this data to the acquisition bus is controlled from the acquisition data console.

(c). Data from the receiver site is actually taken from synchro transmitters on receiving antenna number 1. It comes into the receiver site acquisition data console and from there to the radar site console where it can be switched onto the radar site acquisition bus.

(2). <u>RECEIVER SITE</u>

At the receiver site, data from two sources is available for switching onto the acquisition bus: manual input and radar site data. Data from one of these sources is switched onto the acquisition bus at the receiver site acquisition data console and thereby made available to both of the receiving antennas and to the transmitting antenna.

(a). The manual input to the acquisition system at the receiver site is made with synchro transmitters on the acquisition data console which are positioned by means of handwheels. The receiver site manual input is set either in accordance with predicted data on the capsule azimuth and elevation or in accordance with signal strength indications from telemetry equipment connected to the receiving antennas.

(b). Data from the radar site is taken from the acquisition bus there and transmitted to the receiver site acquisition data console. Under normal conditions of operation this data is to be preferred to the receiver site manual input and is therefore connected to the receiver site bus throughout the duration of a capsule pass.

C. NORMAL OPERATION

The following is a description of the normal sequence of availability, distribution and use of acquisition information during a typical pass of the capsule. This description is given as an aid in understanding the overall operation of the acquisiton system. It should be noted that several variations from the normal sequence are possible. These variations are not discussed in the following description, but should be apparent once the capabilities of the system are understood.

(1). Prior to the pass, predicted target position coordinates--azimuth, elevation, range, and time--are sent to the site in plain text from Goddard Space Flight Center. Coordinates for four or five different times along the orbit are sent: time of arrival at 700 nautical miles range, 30 seconds later, 60 seconds later, 90 seconds later, and time for position just past zenith when a zenith pass of the capsule is expected. The first set of coordinates is read over the intercom to the radar site acquisition data console operator who sets the manual input synchros accordingly and puts this data on the acquisition bus. The active acquisition aid, transmitting, both receiving, and both radar antennas are slaved to the radar site manual input. (The receiving and transmitting antennas usually are slaved through the receiver site acquisition data console to the data on the radar site bus throughout a capsule pass.) If acquisition (automatic tracking) of the capsule is not accomplished at the time specified by the first set of predicted coordinates, the next three of the remaining sets of coordinates are read and set into the system at the times given. The coordinates just past zenith are used as an aid in re-acquiring the capsule if automatic tracking is lost as it passes overhead.

(2). The active acquisition aid acquires the capsule and data from the active acquisition aid is put onto the acquisition bus by the radar site acquisition data console operator. Thus, the active acquisition aid is no longer slaved to the bus (as it is the source of the data on the bus). However, the other antennas at the site remain slaved to the bus.

(3). The Verlort radar acquires the capsule. Since it is more accurate, data from the Verlort is preferred to that from the active acquisition aid; hence Verlort data is switched onto the acquisition bus. The transmitting and receiving antennas and the FPS-16 remain slaved to the bus. The active acquisition aid, however, continues independent automatic tracking.

(4). The FPS-16 radar acquires the capsule. Since it is the most accurate of all the tracking data obtainable, data from the FPS-16 is switched onto the acquisition bus. The transmitting and receiving antennas remain slaved to the bus, and the Verlort radar and the active acquisition aid continue in independent automatic tracking. These conditions--both radars and the active acquisition aid tracking automatically, FPS-16 data on the acquisition bus, and the transmitting and receiving antennas slaved to the bus--are the optimum for the remainder of the capsule pass. They are continued until the capsule goes beyond the range of the FPS-16.

(5). The capsule goes out of range of the FPS-16, but the Verlort is still tracking. FPS-16 data is switched off the bus and Verlort data is switched onto it. The transmitting and receiving antennas remain slaved, and the active acquisition aid continued automatic tracking.

(6). If the Verlort loses automatic tracking before the active acquisition aid, data from the active acquisition aid is switched onto the bus. Otherwise, the Verlort continues to track and its data is kept on the acquisition bus until the capsule pass is complete. In either event, the transmitting and receiving antennas remain slaved to the acquisition bus until all automatic tracking ceases.

4-2. DETAILED DISCUSSION

A. DISCUSSION OF OVERALL SYSTEM

This paragraph discusses the complete acquisition system on a block diagram level. (See figures 4-1 and 4-2.) Paragraph 4-2. B. and subsequent paragraphs discuss individual components and subsystems of the acquisition system.

(1). On the radar site acquisition data console at the data source selector, which in actuality consists of several relays and switches, azimuth and elevation data from one of the five possible sources is put onto the acquisition bus. (The acquisition bus is indicated by the heavy lines on figure 4-1.) This data goes directly to the FPS-16 radar and to synchro line amplifiers number 2 and number 3.

(2). When the FPS-16 is tracking the capsule automatically, it does not use the data from the acquisition bus. When it is not engaged in automatic tracking, however, the FPS-16 can usually be slaved to the bus. (It cannot be slaved to the bus when it is the source of the data on the bus.)

(3). From synchro line amplifier number 3 the data goes to the Verlort radar, which like the FPS-16 can and normally does use data from the acquisition bus except when engaged in automatic tracking or when it is the source of the data on the bus.

(4). From synchro line amplifier number 2 data goes to the active acquisition aid and to the transmitter portion of a transmitter-receiver unit of synchro remoting system number 2.

(a). The active acquisition aid is like the radars in that it can and normally does use data from the acquisition bus except when it is engaged in automatic tracking or when it is the source of the data on the bus.

(b). Through synchro remoting system number 2 data from the radar site acquisition bus is transmitted to the receiver site acquisition data console, where it can be switched onto the acquisition bus going to the receiving and transmitting antennas.

(5). From the receiver portion of the synchro remoting system number 2 transmitter-receiver unit at the receiver site, acquisition bus data goes to the receiver site acquisition data console.

(6). At the receiver site console data source selector, which like the radar site data source selector actually consists of switches and relays, data from one of the two possible sources (manual input and radar site) is connected to those portions of the acquisition bus which go to the receiving antennas and to the transmitting antenna. The data goes first to the receiver site synchro line amplifier.

(7). From the receiver site synchro line amplifier the data goes to receiving antennas number 1 and number 2 and to the transmitter portion of the receiver site transmitter-receiver of synchro remoting system number 1.

(a). Both of the receiving antennas are normally slaved to the data on the acquisition bus at all times during a capsule pass.

(8). Through synchro remoting system number 1 data from the receiver site is supplied to the transmitting antenna and the PMR van. The data comes out of the synchro remoting system and through a synchro line amplifier before going to the transmitting antenna and the PMR van.

(a). Like the receiving antennas, the transmitting antenna and the antenna associated with the PMR van are normally slaved to the data on the acquisition bus at all times during a capsule pass.

(9). Position and display data are fed to the radar site acquisition data console from the manual input, the active acquisition aid, the Verlort radar, the FPS-16 radar, and from receiving antenna number 1 at the receiver site. The manual input comprises two synchro transmitters which are positioned by handwheels; one transmitter and handwheel for azimuth data and one for elevation data. The output of the transmitters goes to the data source selector and to synchro displays.

(10). The active acquisition aid puts out azimuth and elevation position data and azimuth and elevation display data. The outputs come from four separate synchro transmitters, two for position data and two for display data, whose rotors are mechanically coupled to the antenna. Both position and display data are fed to the acquisition data console. The position data is routed to the data source selector where it can be put onto the acquisition bus, and the display data goes to the synchro receiver displays for monitoring.

(11). As with the active acquisition aid, azimuth and elevation data from the Verlort radar is taken from four separate synchro transmitters, two for position data and two for display data. Display data goes through synchro line amplifier number 1 to the acquisition data console where it is displayed by synchro receivers. Position data from the Verlort does not go through the acquisition data console, but is connected to the acquisition bus right at the radar by the radar control relay when the radar is chosen as the source of data for the bus. The radar control relay at the Verlort is energized from the acquisition data console.

(12). As in the case of the Verlort radar, position data from the FPS-16 radar is connected to the acquisition bus at the radar by means of a radar control relay. Like the Verlort relay, the FPS-16 radar control relay is energized from the acquisition data console. Display data from the FPS-16 is fed directly to synchro displays on the acquisition data console.

(13). Emergency slaving data, which actually is receiving antenna number 1 display data, comes from the receiver site through synchro remoting system number 2 to the radar site acquisition data console. At the acquisition data console, this data is connected in parallel to synchro displays and to the data source selector, where it can be connected to the radar site acquisition bus.

(14). At the receiver site, position and display data are fed to the acquisition data console from the radar site, receiving antenna number 1, receiving antenna number 2, the transmitting antenna, and the manual input. The manual input is the same as that at the radar site; it goes to the receiver site data source selector and to synchro displays.

(15). Data from the radar site, as previously described, comes into the receiver site console through synchro remoting system number 2. It is fed in parallel to the data source selector and to synchro receivers, where it is displayed for monitoring.

(16). Display data from both of the receiving antennas is fed directly to the receiver site console, where it is used for monitoring. Display data from receiving antenna number 1 also goes through synchro remoting system number 2 to the radar site console.

(17). Display data from the transmitting antenna comes into the receiver site acquisition data console through synchro remoting system number 1. The data comes into synchro displays on the console, where it is used for monitoring.

(18). D-c indications of equipment operating mode and other information are used in the acquisition system. These indications permit the system operators to monitor the status of the various pieces of equipment, and especially they provide the acquisition data console operators with information they need to control and direct the operation of the system. Five d-c indications come from the active acquisition aid to the radar site acquisition data console. (See figure 4-2.) Two of these are cable wrap indications and three are operating mode indications. The cable wrap indications show which half of its total azimuth travel (540 degrees) the active acquisition aid antenna is in, and when used with the azimuth synchro display from the active acquisition aid permit the acquisition data console operator to tell where the antenna is relative to its azimuth limits. The operating mode indications show whether the active acquisition aid is in its automatic, slaved or manual mode of operation. The automatic and manual tracking mode indicators also go from the active acquisition aid to the Verlort and FPS-16 radars.

(19). Mode indications from both of the radars to the radar site acquisition data console are valid track (automatic tracking of the capsule), slaved and manual. In addition to going to the acquisition data console, the valid track indication from each radar goes to the other. Also, two indications go from the acquisition data console to each radar. These show whether data from the active acquisition aid or from the manual input is on the acquisition bus.

(20). A power-on indication comes from the synchro remoting system number 2 transmitter-receive at the radar site to the radar site acquisition data console. This indication simply shows that primary power has been applied to the synchro remoting transmitter-receiver.

(21). Two d-c indications come from the receiver site acquisition data console to the radar site console. These are slaved and manual indications. They indicate whether the source of data for the acquisition bus at the receiver site is the radar site or the manual input at the receiver site console.

(22). Four d-c indications come from each of the receiving antennas and the transmitting antenna to the receiver site acquisition data console. Two of these from each antenna are cable wrap and two are operating mode indications. The cable wrap indications have the same purpose as the cable wrap indications from the active acquisition aid. The operating mode indications show whether the antennas are slaved to data on the acquisition bus or are being operated manually.

(23). Power-on indications come from each of the synchro remoting transmitter-receivers at the receiver site to the acquisition data console there. As at the radar site, these simply show that primary power has been applied to the transmitter-receivers.

(24). Synchro stator voltages, as shown on figure 4-1, are transmitted from place to place in the acquisition system without voltage transformation. The

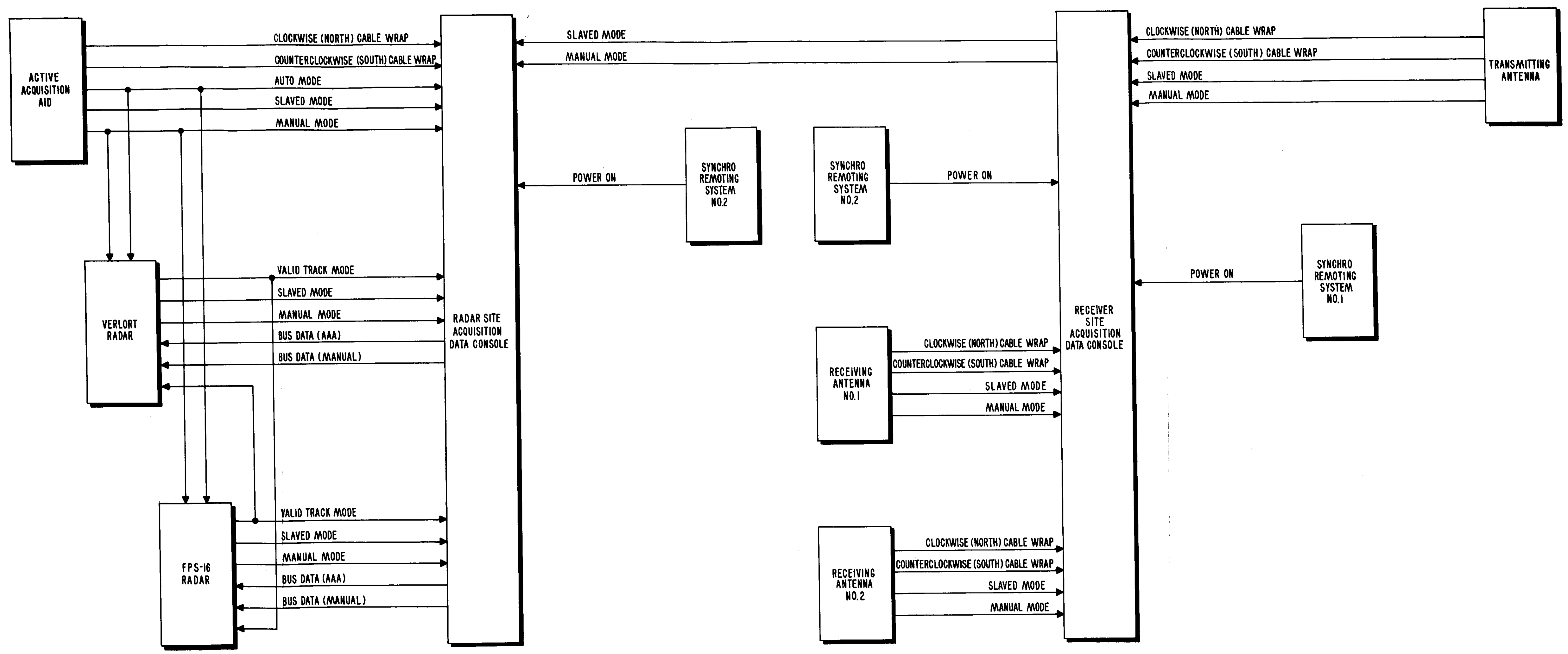


Figure 4-2. Acquisition System D-c Indications, Block Diagram

synchro reference voltages at the radar site, however, undergo voltage step-up and step-down transformations to avoid transmitting relatively large currents over considerable distances. These voltage transformations are shown in simplified form on figure 4-3. Synchro reference voltage of 115 VAC from the radar site power distribution panel is stepped up to 480 VAC for distribution to the equipment in and connected to the acquisition system. A transformer in the radar site acquisition data console steps the 480 VAC down to 115 VAC for use by the synchros in the console, the active acquisition aid, and the synchro remoting system number 2 transmitter-receiver at the radar site. For each of the two radars, a separate transformer steps the 480 volts down to 115 VAC as shown on the illustration. At the receiver and transmitter sites, the distances over which synchro reference voltages must be transmitted are not great, and no reference voltage transformation is required. (For an explanation of the nature and purpose of synchro reference and stator voltages, refer to paragraph 4-2. H. (1).)

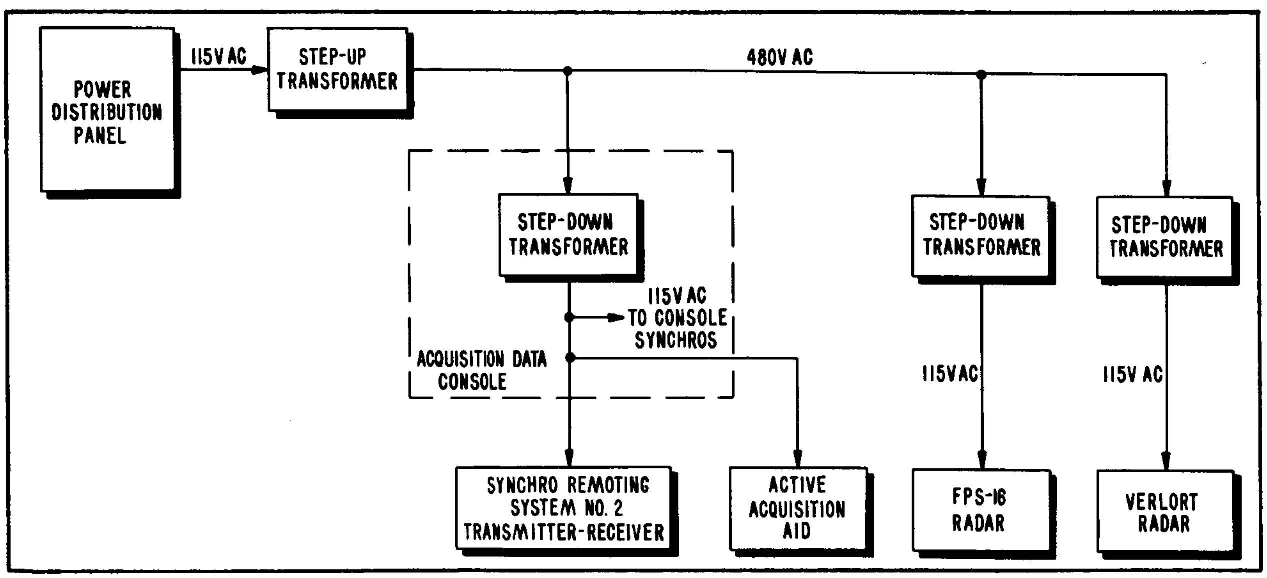


Figure 4-3. Synchro Reference Voltage Transformation and Distribution, Radar Site

B. RADAR SITE ACQUISITION DATA CONSOLE

(1). DUAL POWER SUPPLY

Switches, indicators, and relays on the radar site acquisition data console are energized by 28 VDC from the console 28 VDC supply, which physically consists of relay chassis, two switches on the acquisition data panel, and the dual power supply. The dual power supply consists of four chassis (two power supply units and two filter units) and a front panel. (See figure 7-5.) Primary power, 115 VAC, is applied through jacks J6201 and J6202 to off-on switch S6201. When switch S6201 is closed, primary power is applied through fuses F6201 through F6204 to the primaries of power transformers T6201 and T6202. The fuses are in indicating-type holders; when a fuse blows, a neon bulb in parallel with the fuse is lit. A neon, power-on indicating lamp, DS6201, is across the line going to power supply unit PS6201. Power supply unit PS6201 and filter unit FL6201 make up power supply number 1; it is a conventional d-c power supply with silicon rectifiers in a bridge configuration and with an LC filter. Note that there is a fuse, F6205, on the d-c side of the power supply. This fuse is not in an indicating-type holder. Power supply unit PS6202 and filter unit FL6202 make up power supply number 2, a second d-c power supply which is identical to the first. The secondaries of power transformers T6201 and T6202 have multiple taps to allow adjustment of the output voltage of the power supplies. The voltage difference between pins 1 and 2 is 1.5 VAC and is 3 VAC between pins 3 and 4, 4 and 5, and 5 and 6. Thus, by connecting the a-c leads to the rectifier to different taps on the transformer, the a-c input to the rectifier can be varied over a range of 10.5 volts (rms), and the d-c output of the power supply over a range of approximately 14.5 volts.

(2). POWER SUPPLY CONTROL CIRCUITS

The control circuits for the radar site console power supply are shown in simplified form on figure 4-4. Each of the blocks on figure 4-4 labeled "28 VDC POWER SUPPLY" represents half of the dual power supply discussed in the previous paragraph and shown on figure 7-5. Switches S6006 and S6007 and the indicator lamps are on acquisition data panel number 1; the rest of the components of the control circuits are on the relay chassis which is mounted on the right side of the console.

(a). When switch S6201 on the dual power supply is closed (see figure 7-5), power is applied to power supply number 1 in the dual power supply through manually operated pushbutton switch S6006. The power supply puts 28 VDC on the bus, and relay K6001 is energized. Power is applied through K6001 contacts 5 and 6 to the coil of switch S6006, thus holding switch S6006 closed and keeping the power supply on. With relay K6001 energized, power is applied through K6001 contacts 1 and 2 to the green indicator lamps, which indicate that the power supply is on and operating properly. If power supply number 2 of the dual power supply has not yet been turned on, 28 VDC from power

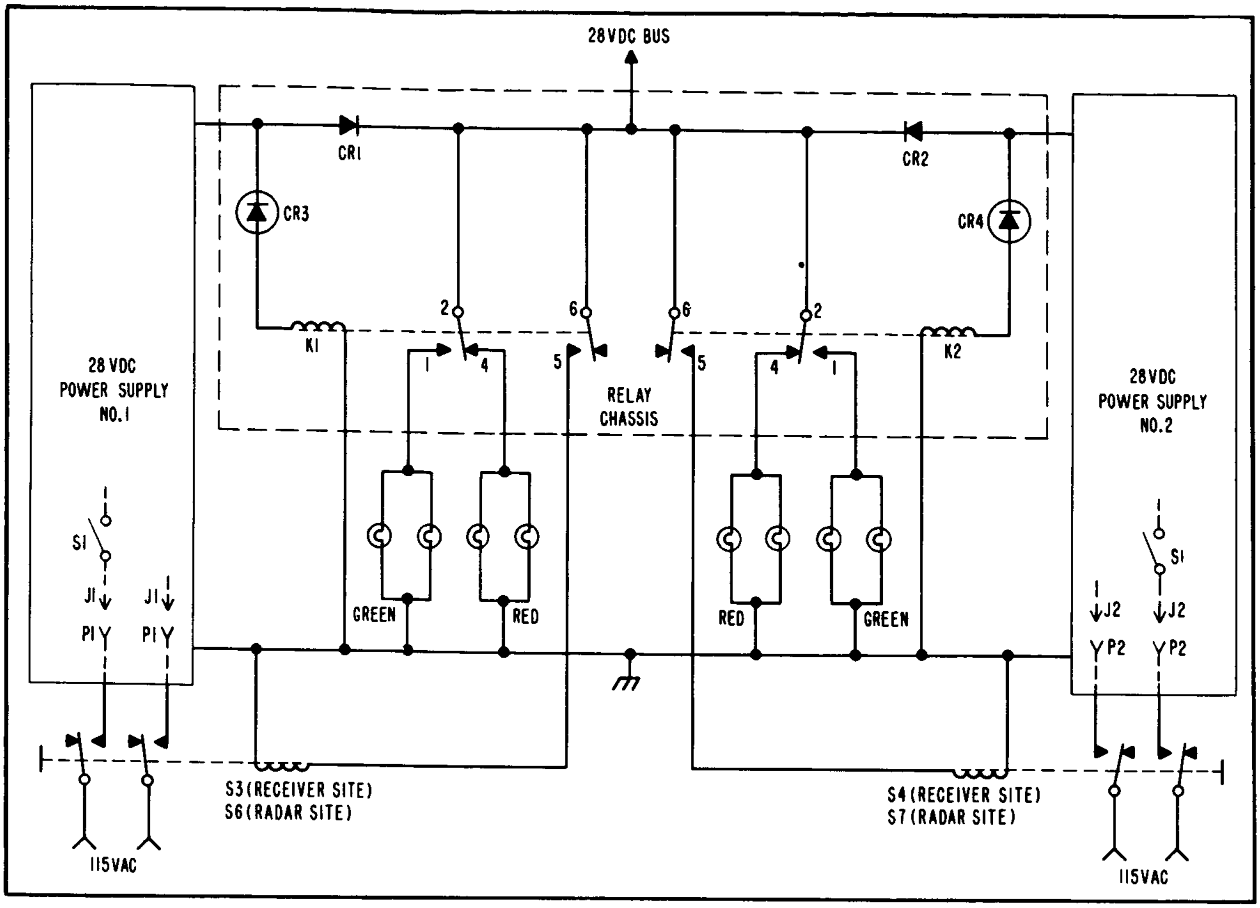


Figure 4-4. Power Supply Control Circuits, Simplified Schematic Diagram

supply number 1 through relay K6002 contacts 2 and 4 lights the red indicator lamps associated with power supply number 2, indicating that it is not on. Rectifier CR6002 prevents current from power supply number 1 from circulating through power supply number 2 and from energizing relay K6002 when power supply number 2 is not on.

Note

The indicator lamps associated with power supply number 1 are in the same physical unit as switch S6006; the lamps associated with power supply number 2 are in the same physical unit as switch S6007.

(b). Zener diode CR6003 in series with the coil of relay K6001 provides a sharp pull-in and drop-out of relay K6001 as the voltage output of power supply number 1 increases or decreases. This action prevents the output of power supply number 1 from being applied to the console 28 VDC bus until it reaches operating value, and in the case of a malfunction resulting in low voltage, disconnects the power supply from the bus. When power supply number 1 is turned on, its voltage output begins to rise. Until the output reaches 18 volts, the resistance of CR6003 is very high, and virtually no current flows through CR6003 and the coil of K6001. As the power supply output increases above 18 volts, the resistance of CR6003 decreases, and rapidly increasing current flows through CR6003 and K6001. (The distinguishing characteristic of zener diodes is that with applied voltages above the diode reference value, 18 volts in this case, and below the maximum rated value, the resistance of the diode varies inversely with the applied voltage; current through the diode varies greatly, but the voltage drop across it remains practically constant. The action of the diode is thus like that of a VR tube.) When the supply voltage reaches approximately 22. 5 volts, sufficient current flows (4. 5 milliamperes) to energize relay K6001. Since the resistance of the relay coil is 1000 ohms, the values of voltage and current in the circuit at this point are as follows:

Total applied voltage	22. 5 VDC
Voltage drop across CR6003.	18. 0 VDC
Voltage drop across K6001 coil	4. 5 VDC
Current $\left(\frac{4.5}{1000}\right)$	4. 5 MA

As the power supply output continues to increase, the voltage drop across CR6003 remains at approximately 18 volts, the current through the circuit increases to about 10 milliamperes, and the voltage drop across the K6001 coil increases to about 10 volts.

(c). If a malfunction develops such that the output voltage of power supply number 1 begins to drop, relay K6001 will drop out sharply at an output voltage of about 22. 5 volts. This action is due to the sharp increase in the resistance of zener diode CR6003 as the voltage across it drops to 18 volts. (As explained in the previous paragraph, with an output from the power supply of 22.5 volts, 4.5 volts appear across the coil of relay K6001, and 18 volts across diode CR6003.) Blocking diode CR6001 prevents current from power supply number 2 from flowing through diode CR6003 and relay K6001. When relay K6001 is de-energized, the holding coil circuit of switch S6006 is opened (by the opening of K6001 contacts 5 and 6), and primary power is disconnected from power supply number 1.

Note

In the preceding and following discussions the values of voltage, current, and resistance given are for purposes of explanation. Actual circuit values vary slightly from those given. For instance, 4.5 milliamperes is the maximum current (per manufacturer's data) which is required for pull-in of relays of the type employed in the control circuit (K6001). The pull-in current for individual relays, however, varies downward from this value. Also, the dropout current of any individual relay is of course less than the pull-in current. Hence, relay K6001 may be expected to pull in at a total applied voltage somewhat less than 22.5 VDC and to drop out at a still lower voltage.

(d). The action of the control circuit of power supply number 2 is identical to that of the control circuit of power supply number 1.

(e). A summary of the action of the power supply control circuits is as follows:

1. Switch S6006 is manually closed, and primary power is applied to power supply number 1 (assuming that switch S6201 on the dual power supply has been closed).

2. Power supply number 1 puts 28 VDC on the bus, energizing relay K6001 and lighting the red indicator lamps in the control circuit of power supply number 2.

3. Relay K6001 closes, lighting the green indicator lamp associated with power supply number 1 and applying power to the

holding coil of switch S6006.

4. Switch S6006 remains closed, and power supply number 1 is in operation.

5. Switch S6007 is closed, and primary power is applied to power supply number 2.

6. Power supply number 2 puts 28 VDC on the bus, in parallel with the power from power supply number 1.

7. Relay K6002 is energized, turning off the red indicator lamps associated with power supply number 2 and lighting the green indicator lamps. Power is applied through K6002 contacts to the holding coil of switch S6007, holding S6007 in the on position. Both power supplies are now in position.

8. Both power supplies are turned off by opening switch S6201 on the dual power supply.

9. If the voltage output of one of the power supplies drops to approximately 22.5 volts, the control relay (K6001 or K6002) associated with the malfunctioning power supply is de-energized and the primary power to that power supply is removed. Power from the other power supply lights the red indicator lamps of the malfunctioning supply. The ratings of the power supplies are such that one of them can supply all of the power required by the console in the event of the failure of the other.

(3). SWITCHES AND INDICATORS

(a). A number of switch assemblies and indicator assemblies are used on the acquisition data panels of the radar site acquisition data console. An exploded view of the type of switch assembly used is shown in figure 4-5. The assembly consists of two main, detachable sections: the switch and the operator-indicator unit with coil. The switch has up to four single-pole, double-throw sections. All of the switch sections are actuated simultaneously by a plunger in the operator-indicator unit. The operator-indicator unit has two main, non-detachable sections: the coil and the indicator. When energized, the coil holds the plunger in its actuated position. The indicator has four lamp sockets, lamps, color filters, and a three-piece display screen. The lamps are white, so the colored lighting of the indicator is obtained by the use of filters which fit over the lamps. The display screen snaps into the end of the indicator plunger when the indicator is assembled, so that the plunger is moved and the switch actuated by depressing the display screen.

(b). The indicator assemblies used on the console are like the operator-indicator unit shown on figure 4-5, except that the indicator assemblies have no coil and no plunger.

(4). CIRCUIT DESCRIPTION (Figure 7-1)

This paragraph gives a detailed description of the circuits of the radar site acquisition data console except for the power supply, which is described in a previous paragraph, and the synchro line amplifiers, which are covered in paragraph 4-2. E.

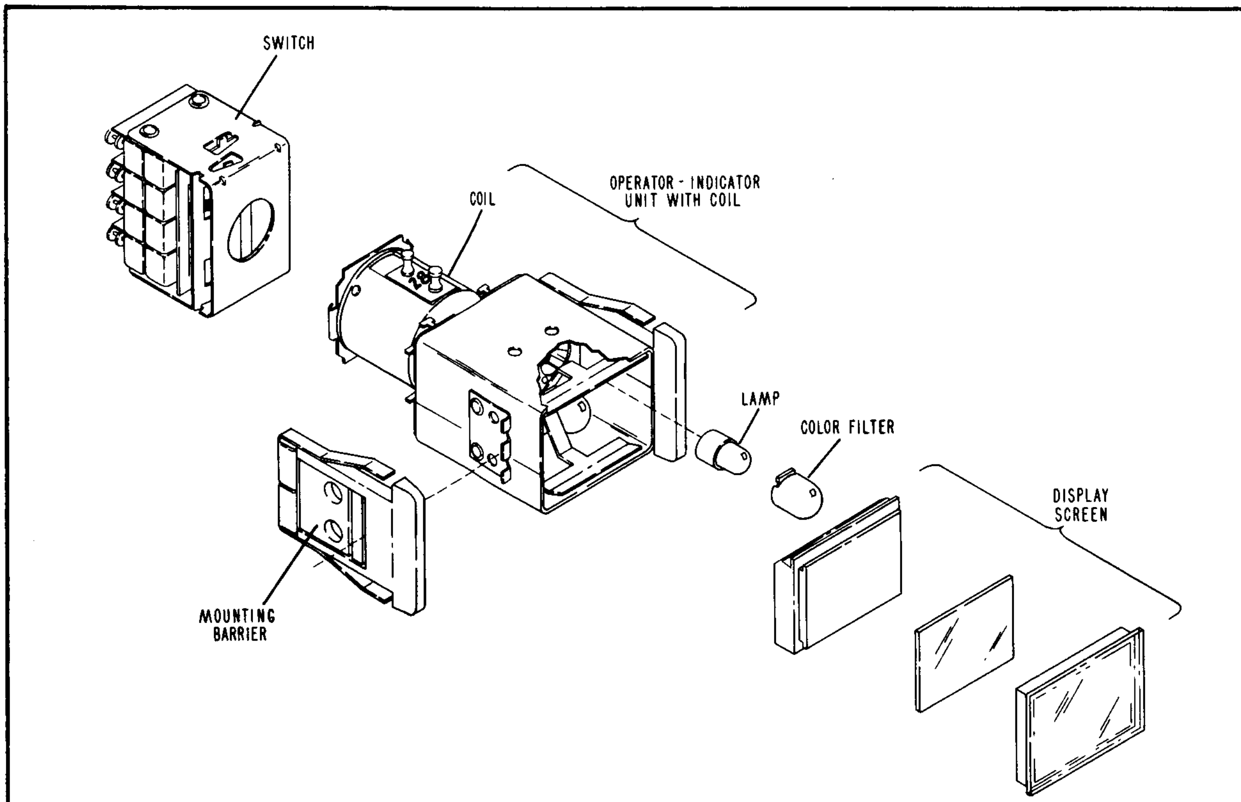


Figure 4-5. Switch Assembly, Exploded View

(a). D-C INDICATIONS

The operating modes of the active acquisition aid, the radars, and the receiver site console, cable wrap status of the active acquisition aid, and the application of power to the synchro remoting transmitter are indicated by lamps on the radar site acquisition data console. Some of these lamps are supplied with 28 VDC from the console power supply, with ground supplied through switches in external equipment; others are connected to ground in the console, and 28 VDC is supplied through switches in external equipment. For instance, when the active acquisition aid is tracking automatically, the active acquisition aid operator closes a switch which connects 28 VDC to terminal 1 of terminal board TB6008 in the console, lighting active acquisition "AUTO" indicators DS6001 and DS6002. Other operating mode indicators on the console are as follows:

1. Manual tracking by the active acquisition aid is indicated by the lighting of active acquisition aid "MANUAL" indicators DS6005 and DS6006, and the slaved mode is shown by "SLAVED" indicators DS6003 and DS6004. One side of the "MANUAL" indicators is connected to 28 VDC in the console, and ground is connected to the other side through the "MANUAL" switch in the active acquisition aid and terminal 3 of console terminal board TB6008. One side of the "SLAVED" indicators is connected to console ground, and 28 VDC is applied to the other side through the "SLAVED" switch in the active acquisition aid and terminal 2 of TB6008 on the console. Active acquisition aid mode indicators in the radars also are connected to TB6008 terminals 1 and 3. Thus, "AUTO" and "MANUAL" mode indications from the active acquisition aid appear in the radars at the same time that they appear on the acquisition data console.

2. The active acquisition aid antenna can rotate 540 degrees in azimuth from its clockwise to its counterclockwise limit. Since it can rotate more than 360 degrees, there are azimuths at which the synchro display alone is ambiguous; i.e., the synchro display shows the azimuth of the antenna, but does not show whether

it is on its first or second time around. Since the antenna cannot rotate continuously, it is necessary to know where it is relative to its limits of rotation so that the operator can position it for maximum freedom of rotation in either direction and can avoid driving it into its limit stops. The ambiguity of the synchro display is resolved by the use of "CABLE WRAP" indicator lamps DS6047 and DS6048 which are lit by the closing of a switch on the antenna pedestal. This switch is so located that it is actuated when the antenna passes the mid-point between its azimuth limits. The DS6047 circuit is closed by the switch and the DS6048 circuit is opened when the antenna is rotating clockwise (looking at it from above); the DS6048 circuit is closed and the DS6047 circuit opened when the antenna is rotating counterclockwise. At installation the antenna is so oriented that the counterclockwise limit is reached at zero degrees (relative to north) and the clockwise limit at 180 degrees. (See figure 4-6.)

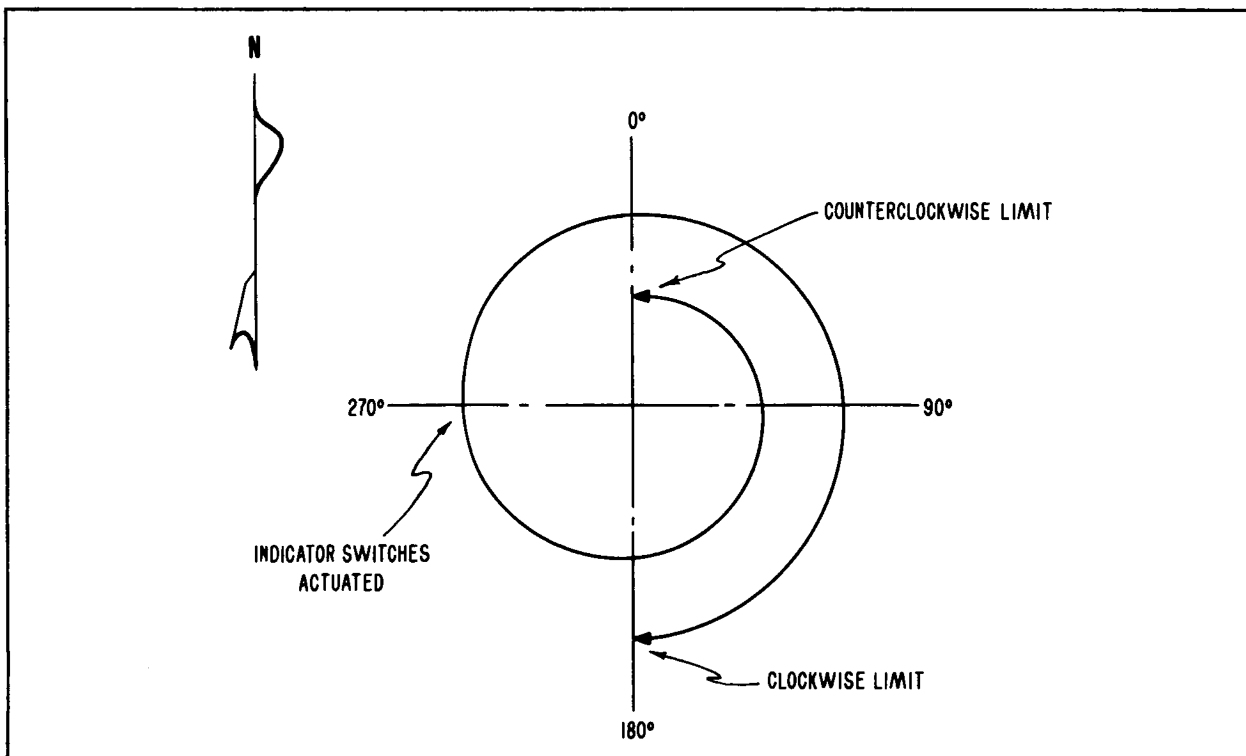


Figure 4-6. Diagrams of Antenna Cable Wrap Limits

With this orientation, the cable wrap indicator switching occurs at 270 degrees. Figure 4-7 illustrates how the cable wrap indicator lamps and the antenna azimuth display synchro together show the acquisition data console operator where the antenna is relative to its limits of rotation. When the upper cable wrap indicator is lit (figures 4-7(A) and 4-7(B)), the antenna has been turned past 270 degrees azimuth in a clockwise direction, and if

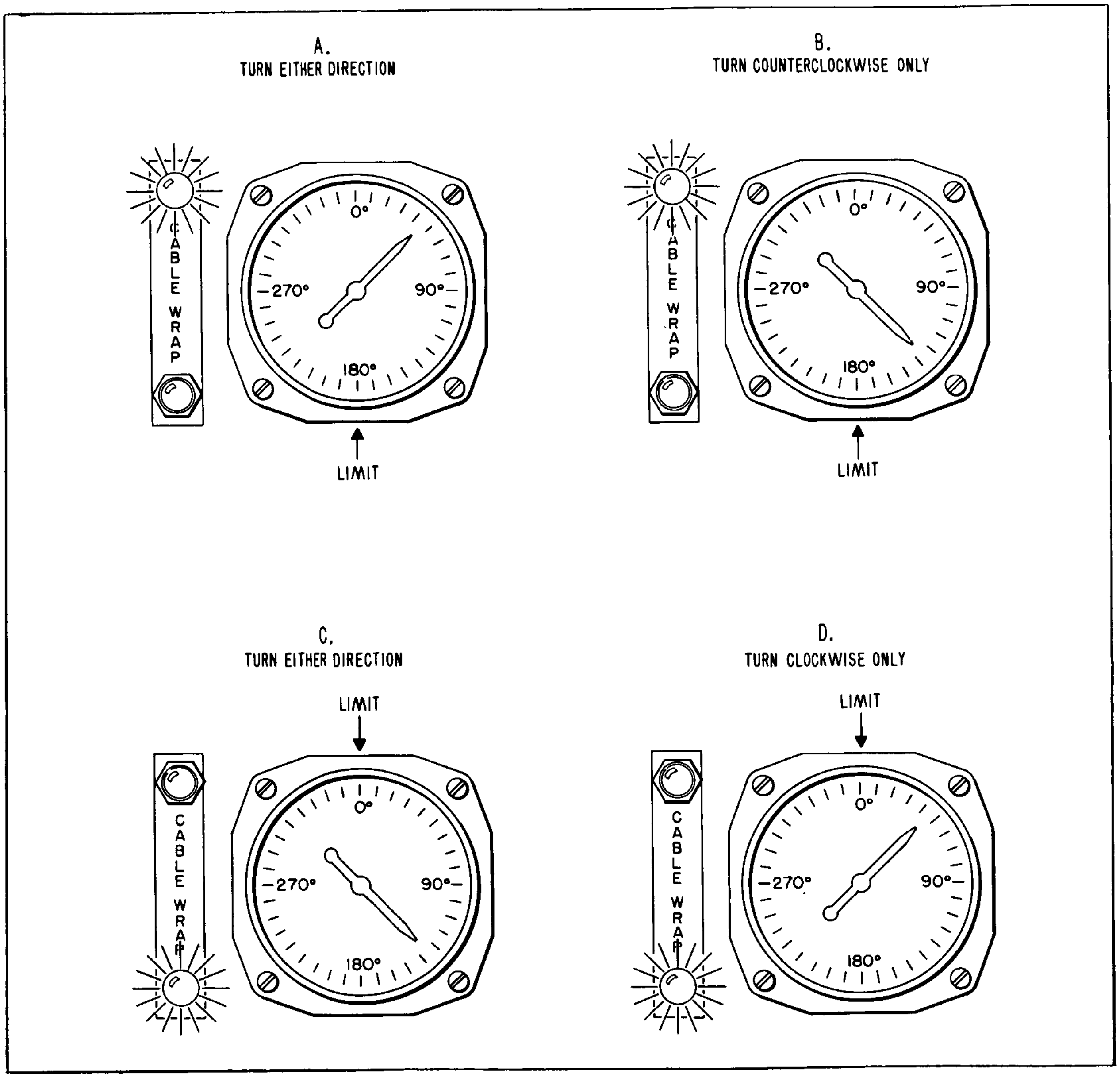


Figure 4-7. Synchro and Lamp Indications of Antenna Bearing Relative to Cable Wrap Limits

it continues in a clockwise direction, the limit of rotation will be reached at 180 degrees azimuth. When the lower indicator is lit (figures 4-7(C) and 4-7(D)), the antenna has been turned past 270 degrees in a counterclockwise direction, and continuing in a counterclockwise direction the limit will be reached at zero degrees. Thus, as long as the synchro pointer is on the half of the dial (upper or lower) which is the nearer to the lighted indicator (figures 4-7(A) and 4-7(C)), there is no limit problem and the antenna can safely be turned in either direction; when the synchro pointer is on the half of the dial opposite the lighted indicator (figures 4-7(B) and 4-7(D)), the antenna is near one of its limits of rotation and care must be exercised not to drive it into the limit stop.

3. The circuits in the active acquisition aid which provide d-c indications to the acquisition data console are shown in partial form on figure 7-19. The mode of operation of the active acquisition aid is determined by the condition (energized or not energized) of a number of mode control relays. When none of these relays is energized, the active acquisition aid is in the manual mode. One group is energized for automatic operation, and another group is energized for slaved operation. The manual mode indicators in the acquisition data console are grounded through normally-closed contacts (3 and 2) of relays K1151 and K1152 in the active acquisition aid servo cabinet field and relay power supply. Relay K1152 is energized for automatic operation, and relay K1151 is energized for slaved operation. Hence, for either operating mode of the active acquisition aid other than manual, ground is removed from the manual indicators on the acquisition data console, and the indicators are extinguished.

4. For automatic operation of the active acquisition aid, "AUTO" switch S67607 on the control console switch panel assembly is closed, thus connecting 28 VDC from the field and relay power supply to mode control relay K1152. In addition to connecting 28 VDC to K1152, the closing of S67607 connects 28

VDC to K1152, the closing of S67607 connects 28 VDC to the "AUTO" mode indicators in the acquisition data console, thus lighting these indicators. (Switch S67607 is a momentary type. After initial application of 28 VDC through S67607, relay K1152 is kept in the energized position by a holding circuit, not shown on figure 7-19.)

5. For slaved operation of the active acquisition aid, "SLAVED" switch S67608 on the switch panel assembly is momentarily closed. Providing that the slaving interlocks on the acquisition data console are closed (the operation of these interlocks is described in paragraph 4-2. B. (4). (c)), this action connects 28 VDC to relay K1151 (and other mode control relays, as shown on figure 7-19), thus energizing it and completing its holding circuit. The 28 VDC on the coil of K1151 is applied in parallel to the "SLAVED" mode indicators on the acquisition data console, thus lighting them.

6. The active acquisition aid cable wrap indicators on the acquisition data console are operated in parallel with the indicators on the active acquisition aid control console. The complete circuit is shown on figure 7-19.

7. The operating mode of the Verlort radar is indicated by "VALID TRACK" indicators DS6010 and DS6011, "SLAVED" indicators DS6013 and DS6014, and "MANUAL" indicators DS6015 and DS6016. (See figures 7-1, 7-17, and 7-18.) One side of the "SLAVED" and "MANUAL" indicators is grounded in the console, and they are lit when 28 VDC is applied through mode switching relays in the radar. The Verlort "VALID TRACK" indicators are connected to the console 28 VDC supply through the C sections of power supply switches S6006 and S6007. The indicators are lit when ground is applied to them through the radar mode switch. This arrangement is necessary for proper operation of data processing equipment, which is connected in parallel with the console "VALID TRACK" indicator,

but does not affect operation of the console indicator. Verlort valid track indicators in the FPS-16 radar and in the radar data selector (part of the site radar data processing equipment) are connected in parallel with the console "VALID TRACK" indicator, as shown on figures 7-1 and 7-18. Hence, a Verlort valid track indication appears in the FPS-16 and the radar data selector at the same time that it appears in the console.

8. The "VALID TRACK" indication from the FPS-16 is supplied to the Verlort and the radar data selector, as well as to the acquisition data console. (See figures 7-1, 7-17, and 7-18.) The three operating mode indicators connected to FPS-16 radar are "VALID TRACK" (DS6020, DS6021), "SLAVED" (DS6023, DS6024), and "MANUAL" (DS6025, DS6026). They are operated in the same manner as the corresponding indicators associated with the Verlort radar.

9. The source of the data on the acquisition bus at the receiver site is shown by "SLAVED" indicators DS6029 and DS6030 and "MANUAL" indicators DS6031 and DS6032. (See figures 7-1 and 7-17.) Data from the radar site is connected to the acquisition bus at the receiver site by the closing of switch S6001 on the receiver site console. When it is closed, section C of this switch connects ground to one side of relay K6003 in the radar site console, thus energizing this relay. When K6003 is energized, ground is connected through contacts 5 and 6 to "SLAVED" indicators DS6029 and DS6030, and the indicators are lit. Switch S6002 on the receiver site console, when closed, connects the receiver site manual input to the acquisition bus there. The closing of section D of this switch connects ground to relay K6004 in the radar site console. This relay is then energized, and ground is applied through contacts 5 and 6 to "MANUAL" indicators DS6031 and DS6032, thus lighting the indicators.

10. "DATA LINK POWER" indicators DS6049 and DS6050 are connected to the radar site transmitter-receiver of synchro

remoting system number 2 in such a manner that they are lit when primary power is applied to the transmitter-receiver. The circuit of these indicators is shown on figures 7-1 and 7-17. One section of two-pole circuit breaker CB1-CB2 on the transmitter-receiver power supply is in series with the "DATA LINK POWER" indicators on the console. When the circuit breaker is closed to apply 115 VAC to the transmitter-receiver, 28 VDC from the console is applied to the indicators. Since the other side of the indicators is connected to ground, they are then lit.

(b). <u>SYNCHRO CIRCUITS (Figures 7-1 and 7-8 through 7-12)</u>
There are five pairs of synchro receivers and one pair of synchro transmitters on the radar site acquisition data console. (For a description of the principles of operation of synchros, refer to paragraph 4-2. H.) One of each pair handles azimuth data and the other elevation data.

1. Azimuth and elevation display data from the active acquisition aid comes into the acquisition data console by way of terminal board TB6002. From there it goes to synchro receivers B6001 (azimuth) and B6002 (elevation), where it is displayed. Position data from the active acquisition aid comes into terminal board TB6007 and goes from there to the contacts of relay K6005, where it is available for switching onto the acquisition bus. As shown on figure 7-8, the position data from the active acquisition aid comes from synchro (control) transmitters B205 and B305 in the active acquisition aid pedestal. The display data comes from synchro transmitters B202 and B302. In addition to going to the acquisition data console, the data from B202 and B302 goes to the active acquisition aid control console, where it is displayed by synchro receivers B1201 and B1202.

2. Azimuth and elevation display data from the Verlort radar comes into the acquisition data console on terminal board TB6010. From there it is routed through TB6027, the contacts of relay K6010, TB6028, synchro line amplifier number 1, and TB6003 to synchro receivers B6003 (azimuth) and B6004

(elevation), where it is displayed. The purpose of relay K6010 is to protect the display receivers (B6003 and B6004) in the acquisition data console and the display data transmitters in the Verlort radar in the event that synchro reference voltage is not applied to the synchros in the console, but is applied to the synchros in the radar. (With reference voltage applied to one of two synchros connected together but not applied to the other, excessive stator currents flow and both of the synchros are likely to be damaged. Relay K6010 is energized by console synchro reference voltage; thus, when synchro reference voltage is not applied to the console, K6010 is de-energized and the stator circuits of B6003 and B6004 are disconnected from the radar. Position data from the Verlort radar does not come into the acquisition data console for switching, but is put onto the acquisition bus at the radar by actuation of the Verlort radar control relay.

3. The synchro circuit connections between the Verlort radar and the acquisition data console are shown on figure 7-10. Display data from synchro transmitters on the radar antenna pedestal comes through terminal boards TB34723 and TB34721 in the radar junction box and jack J11 in the external connector panel. Position data comes through J32 on the external connector panel, through the radar control relay when it is energized, and through J11 on the external connector panel. (For a complete description of the operation of the Verlort radar control relay, refer to paragraph 4-2. B. (4). (d).) Slaving data on the acquisition bus is connected to the Verlort radar through jack J11 in the external connector panel, the normally-closed contacts of the radar control relay, and through synchro line amplifier number 3 to terminal board TB34749 in the radar junction box.

4. Display data from the FPS-16 radar comes into the console on terminal board TB6005. It goes through TB6029, the contacts of relay K6011, TB6030 and to synchro receivers B6005 (azimuth) and B6006 (elevation), where it is displayed. Like

K6010, described in the previous paragraph, K6011 is a protective relay. As in the case of the Verlort radar, position data from the FPS-16 does not come into the acquisition data console for switching, but is put onto the acquisition bus at the radar by actuation of the FPS-16 radar control relay.

5. The synchro circuit connections between the FPS-16 and the acquisition data console are shown on figure 7-11. The FPS-16 data switch, through which all acquisition system synchro data to and from the FPS-16 passes, switches FPS-16 input and output data between Mercury and non-Mercury equipment which is external to the radar. Relays K1 through K4 (and others not shown on figure 7-11) in the data switch unit are energized at all times during Mercury operations. Relay K11 is the FPS-16 radar control relay. Display data from synchro transmitters on the FPS-16 antenna pedestal comes from terminal boards TB18026 and TB18027 in the radar data junction box, through relays K2 and K3 in the data switch unit, and to the acquisition data console. Position data from the radar comes from terminal boards TB18023 and TB18024 in the data junction box, through relays K1 and K2 in the data switch unit, and through the radar control relay K11 (when closed) in the data switch unit to the acquisition bus. (Refer to paragraph 4-2. B. (4). (d). for a complete description of the radar control relay.) Acquisition bus data for slaving the radar is connected through relays K3 and K4 of the data switch unit to terminal boards TB18011 and TB18013 in the data junction box. An interlock circuit prevents the FPS-16 from being slaved to the acquisition bus when it is the source of the data on the bus.

6. Synchro data from the receiver site comes into the acquisition data console on terminal board TB6004. It goes from there in parallel to synchro receivers B6007 (azimuth) and B6008 (elevation), where it is displayed, and to the contacts of relay K6006, where it is available for switching onto the acquisition bus. The synchro circuit connections between the radar and

receiver site consoles are shown on figure 7-12. The synchro data from the receiver site to the radar site is display data from receiving antenna number 1. This data comes into the receiver site acquisition data console for display and is also connected through terminal board TB6014 on the receiver site console to the transmitter portion of the synchro remoting system number 2 transmitter-receiver at the receiver site. In the synchro remoting transmitter-receiver the data is converted from synchro to digital form and transmitted to the radar site. In the receiver portion of the radar site transmitter-receiver unit the data is converted back to synchro form by the synchro synthesizers. These synthesizers are not true synchro devices; they are fixed transformers with multiple-tap windings. Various combinations of the windings are connected by relay contacts to provide incremental voltages which are the close equivalent of the true synchro voltages which are connected to the input to the system at the receiver site. (Refer to paragraph 4-2. G.) The synthesized synchro signals which are developed at the radar site are connected to terminal board TB6004 of the radar site acquisition data console. In the same manner, the acquisition bus data from the radar site acquisition data console is transmitted through synchro remoting system number 2 to the receiver site. (See figure 7-12.) At the receiver site, data from the radar site coming out of the synchro remoting system is routed through TB120 in the receiving antenna number 1 servo rack to TB6006 on the receiver site acquisition data console.

7. The manual input to the acquisition bus at the radar site is made by means of synchro transmitters B6011 and B6012 — B6011 for elevation and B6012 for azimuth data. The output of these synchro transmitters is available at relay K6007 for switching onto the acquisition bus and is also wired directly to manual display synchro receivers B6009 (elevation) and B6010 (azimuth). Note that the S1-S3 connections from the manual

synchro transmitters to the manual display receivers and to the acquisition bus are reversed. This reversed condition is necessary to obtain the proper output from the manual synchro transmitters because of a direction reversal that occurs in the gearing between the transmitter handwheels and the transmitters. To set data into the manual synchro transmitters, the console operator turns the transmitter handwheels and observe the manual receiver displays. There is no dial on the handwheels or the transmitters themselves to indicate their position.

8. Reference voltage for all of the synchros on the console is supplied from transformer T6001. Note that the synchro reference voltage circuit is separate from the 115 VAC which provides primary power for the console 28 VDC power supply and the synchro line amplifiers in the console.

(c). <u>DATA SWITCHING (Figure 7-1)</u>

The switching of data onto the acquisition bus from one of the five available sources (manual input, active acquisition aid, Verlort radar, FPS-16 radar, and receiver site) is controlled by switches S6001, S6002, S6003, S6004, and S6005. These switches (and switches S6006 and S6007 associated with the 28 VDC power supply) are switch assemblies of the type described in paragraph 4-2.B.(3). and illustrated in figure 4-5.

1. Switch S6001 is the active acquisition aid "SOURCE" switch. When the plunger of S6001 is depressed, 28 VDC from the console d-c bus is applied through section A to the switch holding coil and through section B to indicator lamps DS6007 and DS6008. The lamps are lit, and the holding coil, which is grounded through the common and normally-closed contacts of S6002C, S6003B, S6004C, and S6005C, is energized. The action of the coil holds the plunger of S6001 in its depressed position. The common and normally-closed contacts of S6001A are in series with the 28 VDC supply to the other source switches; thus, when the plunger of S6001 is depressed, the 28 VDC supply to S6002 through S6005 is interrupted, and whichever (if any)

of them had previously been energized is de-energized. With switch S6001 closed (plunger depressed), 28 VDC is supplied through the common and normally-open contacts of section B to the coil of relay K6005, energizing this relay and connecting position data from the active acquisition aid to the acquisition bus.

2. Also with switch S6001 closed, 28 VDC is supplied through the common and normally-open contacts of section B to terminal 1 of TB6015. This terminal is connected to the acquisition bus "AAA" (active acquisition aid) mode indicator in the radars. (See figure 7-18.) Thus, when S6001 is closed, there is an indication in the radars that data from the active acquisition aid is on the acquisition bus.

3. The common and normally-closed contacts of sections C and D of S6001 are in series with portions of the mode control circuits in the active acquisition aid. When S6001 is actuated, the active acquisition aid cannot be slaved to the data on the acquisition bus. This arrangement prevents the active acquisition aid from being slaved to data for which it is the source. The pertinent portions of the active acquisition aid mode control circuits are shown on figure 7-19. For the active acquisition aid to be slaved to the acquisition bus, switch S67608 on the control console switch panel assembly is momentarily depressed. If the interlocks on the acquisition data console are closed (switch S6001 not actuated), the depressing of S67608 applies 28 VDC from the field and relay power supply in the servo cabinet through TB87504-2 to the coils of relay K1151 and the azimuth and elevation mode control relays shown on figure 7-19. The energizing of these relays puts the active acquisition aid into the slaved mode of operation. Since switch S67608 is a momentary type, a holding circuit is required to keep K1151 and the mode control relays energized after S67608 is released. In the holding circuit, 28 VDC is supplied to the coils of the relays from TB87504-7 through normally-closed contacts of S67606, the

interlock on the acquisition data console (S6001D), normally-closed contacts of S67607, and normally-open contacts 7 and 5 of K1151. Hence, when switch S6001 on the acquisition data console is actuated, the normally-closed contacts of section C prevent the active acquisition aid from being switched into the slaved mode, and the normally-closed contacts of section D of S6001 prevent the active acquisition aid from staying in the slaved mode even if it was already in that mode when S6001 was actuated.

4. Switch S6002 is the Verlort radar "SOURCE" switch. When the plunger of this switch is depressed, the common and normally-closed contacts of section C are opened, thus breaking the circuit of the holding coil of switch S6001. If switch S6001 had previously been energized, it is now de-energized, and 28 VDC is applied through the common to the normally-open contacts of sections A and B of S6002. The 28 VDC through section A is applied to the holding coil of S6002, and the 28 VDC through section B is applied to indicator lamps DS6017 and DS6018, which then light. The coil of S6002 is grounded through S6003B, S6004C, and S6005C; when energized it holds the plunger of S6002 in the actuated position. When S6002 is closed, 28 VDC through the common and normally-open contact of section B is also applied through TB6015-6 to the coil of the Verlort radar control relay (in the radar). The Verlort radar control relay is energized, putting data from the radar onto the acquisition bus. The common and normally-closed contacts of S6002A are in series with the 28 VDC supply to switches S6003, S6004, and S6005; hence, when S6002 is actuated, the 28 VDC supply to switches S6003, S6004, and S6005 is interrupted, and if any of them had been energized, it is now de-energized. The common and normally-closed contacts of section D of S6002 are in series with the slaving control circuits in the Verlort. When S6002 is actuated, the Verlort cannot be slaved to the acquisition bus. (The radar control relay in the Verlort duplicates

this interlocking function. The radar control relay is wired in such a manner that it inherently prevents the Verlort from being slaved to its own synchro output. Refer to paragraph 4-2. B. (4). (d).)

5. Switch S6003 is the FPS-16 radar "SOURCE" switch. When the plunger of this switch is depressed, the common and normally-closed contacts of section B are opened, thus breaking the circuit of the holding coils of switches S6001 and S6002. If either of these switches had been energized, it is now de-energized, and 28 VDC is applied through the common to the normally-open contact of section A of S6003. This 28 VDC is then applied to the holding coil of S6003 and to indicator lamps DS6027 and DS6028. These indicator lamps and the coil of S6003 are grounded through the normally-open and common contacts of S6003B. Hence, the lamps are lit and the coil is energized. When energized, the coil holds the plunger of S6003 in the actuated position. The 28 VDC on the normally-open contact of section A, in addition to being applied to the indicator lamps and switch coil, is applied through terminal TB6014-8 to the coil of the FPS-16 radar control relay, energizing this relay and putting position data from the FPS-16 on the acquisition bus. The common and normally-closed contacts of S6003A are in series with the 28 VDC supply to switches S6004 and S6005, so that when S6003 is actuated, the 28 VDC supply to S6004 and S6005 is interrupted, and if either of these switches had been energized, it is now de-energized. The common and normally-open contacts of S6003 sections C and D are connected to slaving control circuits in the FPS-16 radar in such a manner that when S6003 is actuated, the FPS-16 cannot be slaved to the acquisition bus. Thus, the FPS-16 is prevented from being slaved to the output of its own synchros. The connections of this interlock circuit between the acquisition data console and the FPS-16 are shown on figure 7-21.

6. Switch S6004 is the receiver site (remote site) "SOURCE" switch. When the plunger is depressed, the common and normally-closed contacts of section C are opened, thus breaking the circuit of the holding coils of S6001 through S6003. Any of these switches which had been energized is now de-energized and 28 VDC is applied through the common to the normally-open contacts of S6004A, S6004B, and S6004D. The 28 VDC through the A section is applied to the holding coil of S6004, the 28 VDC through the B section is applied to indicator lamps DS6033 and DS6034, which then light, and the 28 VDC through the D section is applied to the coil of relay K6006. The coils of S6004 and K6006 are grounded through normally-closed contacts 2 and 4 of relay K6003 and through S6005C. When S6004 is depressed (with K6003 unenergized) the holding coil of S6004 holds the plunger in the actuated position and relay K6006 is energized, connecting synchro data from the receiver site to the radar site acquisition bus. Relay K6003 is energized when the receiver site console is slaved to the radar site acquisition bus. When relay K6003 is energized, the grounding circuit for the coils of S6004 and K6006 is opened and data from the receiver site cannot be put onto the radar site acquisition bus. Thus, the radar site console and the receiver site console are provided with an interlock circuit which prevents the two consoles from being slaved to each other. The common and normally-closed contacts of S6004A are in series with the 28 VDC supply to S6005; consequently, when S6004 is actuated, the 28 VDC supply to S6005 is interrupted, and if S6005 had been energized, it is now de-energized.

7. Switch S6005 is the manual "SOURCE" switch. Section C of this switch is in series with the holding coils of switches S6001 through S6004. When S6005 is actuated (plunger depressed), the holding coil circuits of S6001 through S6004 are opened, de-energizing whichever (if any) of these switches had been energized. Twenty-eight volts d-c is applied through the

normally-open contacts of S6005A and S6005B to the holding coil of the switch and to indicator lamps DS6035 and DS6036. The lamps are lit, and the coil is energized, holding the switch plunger in the actuated position. The 28 VDC on the normally-open contact of S6005B also is applied to the coil of relay K6007 and terminal 7 of TB6014. Relay K6007 is energized and manual input data is connected to the acquisition bus. The 28 VDC on TB6014-7 is applied to the "MANUAL" indicators in the radars; when S6005 is closed, there is an indication in the radars that data from the acquisition data console manual input is on the acquisition bus. The interconnecting circuits for this manual indication between the radar site acquisition console and the Verlort and FPS-16 radars are shown on figure 7-18.

8. "NO DATA ON BUS" indicators DS6037 and DS6038 are supplied with 28 VDC in series with the common and normally-closed contacts of the A sections of S6001 through S6005. The indicator lamps are lit as long as the console 28 VDC power supply is on and none of the five source switches has been actuated; when any one of them is actuated, the 'NO DATA ON BUS' indicator lamps are out.

9. As described in the preceding paragraphs, switches S6001 through S6005 are electrically interlocked; when any one of them is actuated by depressing the plunger, d-c power to the coils of all the others is interrupted. If two or more are actuated at the same time (which should never happen), they open each other's circuits; neither holding coil is energized, and only the one electrically nearer the 28 VDC supply connects data to the bus. For example, if S6001 and S6005 both happened to be depressed at the same time, the depressing of S6005 would have no effect since the 28 VDC to it would be interrupted by the depressing of S6001. Since 28 VDC would be applied to S6001, relay K6005 would be energized and data from the active acquisition aid would be put on the acquisition bus. However, the holding coil circuit of S6001 would be opened by the depressing

of S6005, and S6001 would not remain depressed when it was released.

10. When the dual power supply on the console is first turned on, none of the "SOURCE" switches is actuated. After any one of them has been actuated, or turned on, they all can be de-energized, or turned off, only by turning off the dual power supply with switch S6201 (on the front of the dual power supply panel).

(d). RADAR CONTROL RELAYS

1. The manner in which the Verlort control relay connects the Verlort radar to the acquisition bus is shown in simplified form on figure 4-8. When the relay is not energized, data on the acquisition bus is connected through the common and normally-closed contacts of the relay to synchro line amplifier number 3 and thence to the slaving input circuits (remote data input) of the

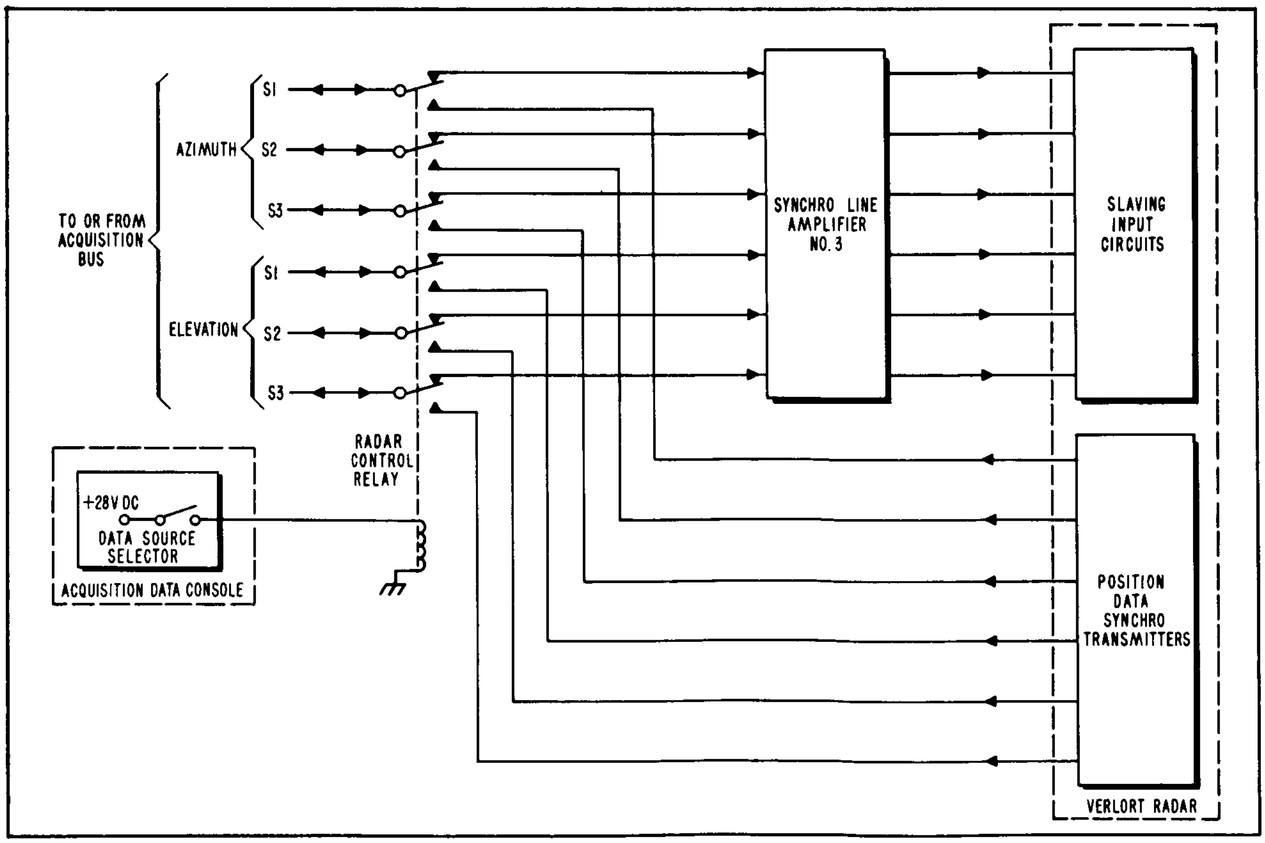


Figure 4-8. Verlort Radar Control Relay Circuit, Simplified Schematic Diagram

radar. Thus, with the control relay unenergized the Verlort may, at the option of the Verlort operator, be slaved to the acquisition bus. The radar control relay is energized by the application of 28 VDC from switch S6002 on the radar site acquisition data console. This switch is shown in simplified form on figure 4-8 as part of the data source selector. When the relay is energized, the input to the radar is disconnected from the acquisition bus, and the position data output of the radar is connected. The radar control relay is mounted on the master-slave relay panel in the Verlort van. A complete schematic of the relay panel and the connecting circuit is shown on figure 7-10.

2. The manner in which the FPS-16 radar control relay connects data from the FPS-16 to the acquisition bus is shown in simplified form on figure 4-9. When the relay is energized, the position data output of the radar is connected to the acquisition bus.

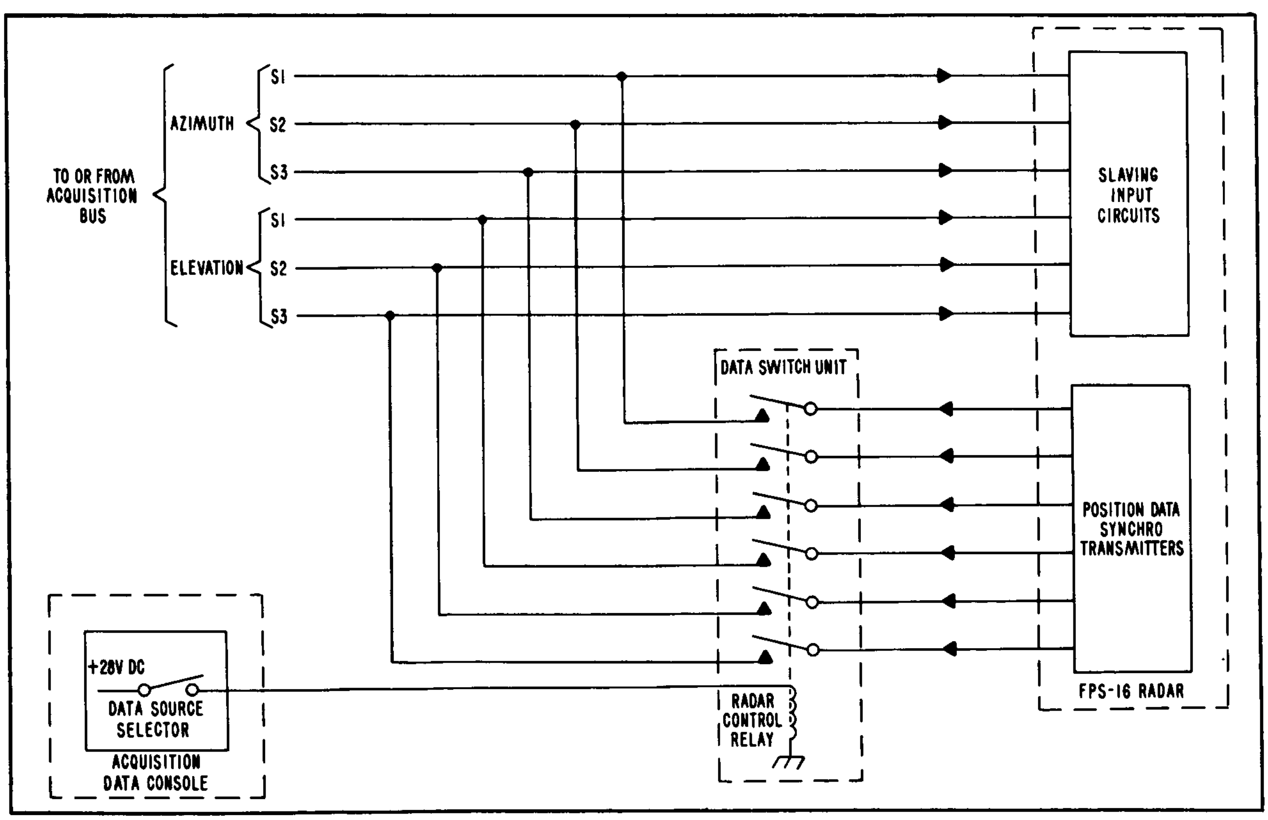


Figure 4-9. FPS-16 Radar Control Relay Circuit, Simplified Schematic Diagram

Unlike the arrangement provided by the Verlort radar control relay circuit, the acquisition bus data is available at the FPS-16 slaving input circuits even when the FPS-16 control relay is energized. Therefore, an interlock circuit is used (refer to paragraph 4-2. B. (4). (c). (5) to prevent the FPS-16 from being slaved to its own output. The FPS-16 radar control relay is energized by the application of 28 VDC from switch S6003 on the radar site acquisition data console. This switch is shown in simplified form on figure 4-9. The control relay is in the data switch unit in the FPS-16 building. Figure 7-11 shows the complete circuit of the control relay (K11) in the data switch unit. It should be noted that the other relays shown on figure 7-11 are energized at all times during Mercury operations and are not used in the switching of data onto the acquisition bus.

C. RECEIVER SITE ACQUISITION DATA CONSOLE

(1). DUAL POWER SUPPLY AND CONTROL CIRCUITS, SWITCHES, AND INDICATORS

The dual power supply and power supply control circuits in the receiver site acquisition data console are the same as those in the radar site console except for the reference designations of the "28V SUPPLY" switches. As shown on figure 4-4, at the radar site these are S6006 and S6007; at the receiver site they are S6003 and S6004. For a description of the dual power supply and its control circuits, refer to paragraph 4-2. B. (1) and (2). The switches and indicators on the receiver site acquisition data console are the same type as those on the radar site console. For a description of them, refer to paragraph 4-2. B. (3).

(2). CIRCUIT DESCRIPTION (Figure 7-3)

This paragraph gives a detailed description of the circuits of the receiver site acquisition data console except for the power supply, which is covered in a previous paragraph, and the synchro line amplifier, and audio amplifier, which are covered in paragraphs 4-2. E. and 4-2. F., respectively.

(a). D-C INDICATIONS (Figures 7-3 and 7-22)

Cable wrap status and the operating mode of the transmitting antenna and both receiving antennas and the application of primary power to synchro remoting system units is indicated by lamps on the receiver site acquisition data console. In general, the circuitry of these indicators is similar to that of the indicators on the radar site console.

1. The operating mode of the transmitting antenna is indicated by "MANUAL" indicators DS6005 and DS6006 and "SLAVED" indicators DS6003 and DS6004. When the transmitting antenna is in the manual mode of operation, ground is applied through switches in the transmitting antenna servo rack to the coil of relay K6006 on the acquisition data console. This relay is energized, and ground is connected through its contacts 1 and 2 to indicators DS6005 and DS6006, thus lighting them. When the transmitting antenna is in the slaved mode of operation, ground is applied through switches in its servo rack to the coil of relay K6005 on the acquisition data console, energizing it and thereby lighting indicators DS6003 and DS6004.

2. The two channels, azimuth and elevation, of the transmitting antenna drive system are independent of one another to the extent that either channel can be operated in the slaved or manual mode while the other channel is operated in the other mode. The "LOCAL-REMOTE" (mode) switches of the antenna are connected to the operating mode indicators on the acquisition data console in such a manner that only when both channels of the antenna drive system are slaved to the acquisition bus is a "SLAVED" indication given on the acquisition data console. If either channel of the antenna drive system is being operated manually, a "MANUAL" indication appears on the acquisition data console. The circuit connections which result in these indications are shown in simplified form on figure 4-10. From the illustration it can be seen that when both the azimuth and elevation "LOCAL-REMOTE" switches are in the "REMOTE" (slaved) position, ground is applied to the "SLAVED" indicator on the acquisition data console; when either "LOCAL-REMOTE" switch is in the "LOCAL" (manual) position, ground is applied

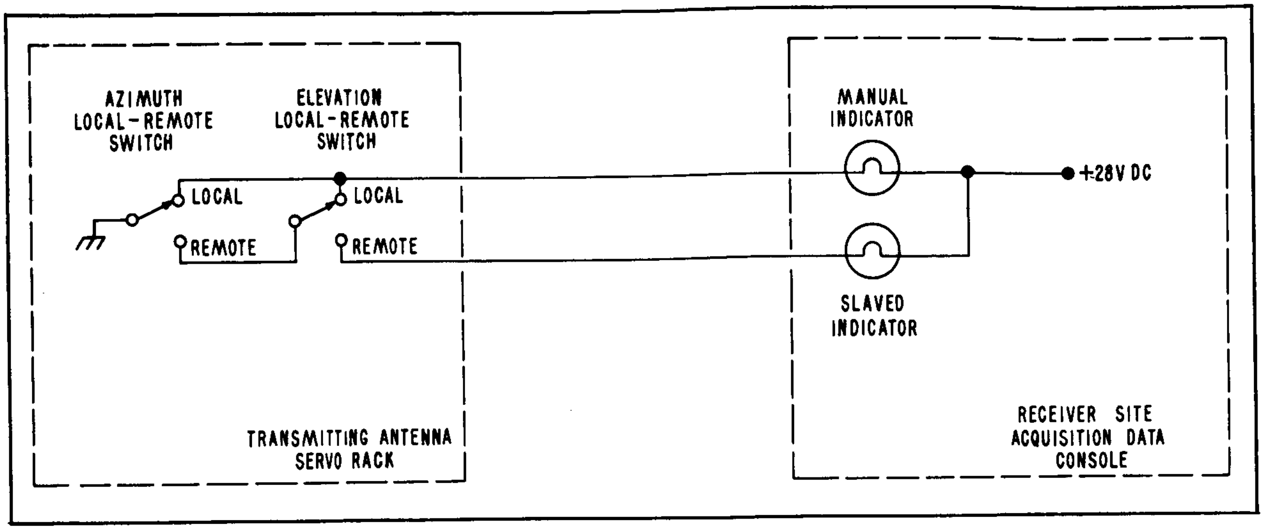


Figure 4-10. Transmitting and Receiving Antenna Mode Indication Circuit, Simplified Schematic Diagram

to the "MANUAL" indicator on the console. The complete transmitting antenna mode indicating circuit is shown on figure 7-22.

3. The transmitting antenna "CABLE WRAP" indicators on the receiver site acquisition data console perform the same function as the active acquisition aid cable wrap indicators on the radar site console. (Refer to paragraph 4-2. B. (4). (a). 2. and figure 7-19.) However, the circuitry of the transmitting antenna indicators is somewhat different. As shown on figure 7-22, ground in the acquisition data console is connected to the arm of auxiliary cable wrap switch S204 on the transmitting antenna pedestal. When the transmitting antenna passes the midpoint of its azimuth travel going in a clockwise direction, cable wrap switch S204 connects ground to the coil of relay K6007 on the acquisition data console. This relay is energized, connecting ground through its contacts to north cable wrap indicator DS6029. When the transmitting antenna passes its azimuth-travel midpoint in the counterclockwise direction, switch S204 connects ground to the coil of relay K6008. This relay is energized and south cable wrap indicator DS6030 is lit. In contrast to the

active acquisition aid cable wrap indicator circuit at the radar site, the circuit which provides transmitting antenna cable wrap indications to the receiver site acquisition data console is electrically independent of the cable wrap indication circuit on the antenna servo rack.

4. For receiving antenna number 1 the mode indicators are DS6009 and DS6010 ("MANUAL") and DS6007 and DS6008 ("SLAVED"); the cable wrap indicators are DS6031 (north) and DS6032 (south). For receiving antenna number 2 the mode indicators are DS6013 and DS6014 ("MANUAL") and DS6011 and DS6012 ("SLAVED"); the cable wrap indicators are DS6033 (north) and DS6034 (south). These indicators are operated by switches in the antenna servo racks and pedestals in the same manner as the transmitting antenna indicators, except that 28 VDC is applied to the indicators on the console instead of ground, and that the receiving antenna indicators are operated directly and not indirectly through relays in the acquisition data console. (See figure 7-22.)

5. At the receiver site, the application of primary power to the synchro remoting system number 1 transmitter-receiver is indicated by "DATA LINK POWER NO. 1" indicators DS6019 and DS6020. For the synchro remoting system number 2 unit, this function is performed by "DATA LINK POWER NO. 2" indicators DS6039 and DS6040. As shown on figure 7-22, these indicators are operated in the same manner as the data link power indicator on the radar site console. (Refer to paragraph 4-2. B. (4). (a). (10.).

(b). SYNCHRO CIRCUITS (Figures 7-3 and 7-12 through 7-16) There are five pairs of synchro receivers and one pair of synchro transmitters on the receiver site acquisition data console. (For a description of the principles of operation of synchros, refer to paragraph 4-2. H.) One of each pair handles azimuth data and the other elevation data.

1. Position data from the radar site comes into the receiver site console on terminal board TB6006. From there it goes to synchro receivers B6001 (azimuth) and B6005 (elevation), where it is displayed. Data from the radar site also is connected from TB6006 to the contacts of relay K6003, where it is available for switching onto the acquisition bus. The interconnecting circuits between the receiver site and the radar site, including synchro remoting system number 2, are shown on figure 7-12 and are described in paragraph 4-2. B. (4). (b). 6.

2. Data from the transmitting antenna comes into the receiver site console on TB6002 and goes from there to synchro receivers B6002 (azimuth) and B6006) (Elevation) for display. As shown on figure 7-13, this data originates at synchro display transmitters B202 (azimuth) and B302 (elevation) on the transmitting antenna pedestal. It is transmitted to the receiver site console through synchro remoting system number 1. (Refer to paragraph 4-2. B. (4). (b). 6. for a brief description of how a synchro remoting system works. Also see paragraph 4-2. G.) Acquisition bus data going from the receiver site to the transmitting antenna also is transmitted through synchro remoting system number 1. At the transmitting antenna servo rack the data comes into a synchro line amplifier. From the synchro line amplifier, data is supplied to the PMR van for slaving the antenna associated with the van and to the azimuth and elevation "LOCAL-REMOTE" switches, S102 and S101, in the transmitting antenna servo rack. When the "LOCAL-REMOTE" switches are in the "REMOTE" position, the data from the acquisition bus is connected to control transformers B203 and B303 for slaving the antenna.

3. Data from receiving antenna number 2 comes into the receiver site console on terminal board TB6005. From there it goes to synchro receivers B6004 (azimuth) and B6008 (elevation), where it is displayed. The synchro circuit connections

between receiving antenna number 2 and the receiver site console are shown on figure 7-15. Except for the fact that the connections between the antenna and the console are direct (not through a synchro remoting system), these circuits are essentially the same as the corresponding circuits between the console and the transmitting antenna, previously described. Compare figures 7-13 and 7-15.

4. Receiving antenna number 1 data comes into the console on terminal board TB6004. It goes from there in parallel to display synchro receivers B6003 (azimuth) and B6007 (elevation) and to terminal board TB6014. From TB6014 it is connected through synchro remoting system number 2 to the radar site console, where it is available for use as emergency slaving data. Refer to paragraph 4-2. B. (4). (b). 6. and figure 7-12. The synchro circuit connections between receiving antenna number 1 and the console are virtually the same as those of receiving antenna number 2. See figure 7-15.

5. Except for differences in some reference designations, the circuitry of the manual input on the receiver site acquisition data console is the same as that on the radar site console. Compare figures 7-1 and 7-3 and refer to paragraph 4-2. B. (4). (b). 7.

6. In contrast to the radar site console, the synchro reference voltage in the receiver site console is taken from the same source as the primary power (115 VAC) for the dual power supply, the synchro line amplifier in the console, and the audio amplifier. No synchro reference voltage transformation is employed at the receiver site.

(c). DATA SWITCHING

The switching of data onto the acquisition bus at the receiver site from one of the two available sources (manual input and radar site data) is controlled by switches S6001 and S6002. These switches (and switches S6003 and S6004 associated with the 28 VDC power supply) are switch assemblies of the type described in paragraph 4-2. B. (3). and illustrated in figure 4-5.

1. Switch S6001 is the radar site "SOURCE" switch. When the plunger of S6001 is depressed, 28 VDC from the console d-c bus is applied through section A to the switch holding coil and to indicator lamps DS6015 and DS6016. The lamps are lit, and the holding coil, which is grounded through the common and normally closed contacts of S6002C is energized. The action of the coil holds the plunger of S6001 in its depressed position. The common and normally closed contacts of S6001A are in series with the 28 VDC supply to S6002; hence, when the plunger of S6001 is depressed, the 28 VDC supply to S6002 is interrupted, and if S6002 had been energized, it is now de-energized. With S6001 closed (plunger depressed), 28 VDC is supplied through the common and normally open contact of section B to the coil of relay K6003, energizing this relay and connecting position data from the radar site to the receiver site acquisition bus. Also with S6001 closed, ground is connected through the common and normally open contacts of section C to terminal TB6013-8. Ground on this terminal energizes relay K6003 on the radar site console which provides an indication on the radar site console that data from the radar site is connected to the acquisition bus at the receiver site. It also prevents the radar site console from being slaved to the receiver site console when S6001 on the receiver site console has been actuated. (See figures 7-3 and 7-17 and refer to paragraphs 4-2. B. (4). (a). 9. and 4-2. B. (4). (c). 5.)

2. Switch S6002 is the manual input "SOURCE" switch. Section C of this switch is in series with the holding coil of switch S6001. When S6002 is actuated (plunger depressed), the holding coil circuit of S6001 is interrupted, de-energizing this switch if it has been energized. Twenty-eight volts d-c is applied through the common and normally open contacts of S6002A

to the holding coil of this switch and to indicator lamps DS6017 and DS6018. The lamps are lit, and the coil is energized, holding the switch plunger in the actuated position. Twenty-eight volts d-c also is applied through the common and normally open contacts of S6002B to the coil of relay K6004. Relay K6004 is energized, and manual input data is connected to the acquisition bus. With S6002 closed, ground is connected through the common and normally open contacts of section D to terminal 7 of TB6013. The connection of ground to this terminal provides an indication on the radar site console that receiver site console manual input is connected to the acquisition bus at the receiver site. (See figure 7-17 and refer to paragraph 4-2. B. (4). (a). 9.)

3. "NO DATA ON BUS" indicators DS6001 and DS6002 are supplied with 28 VDC in series with the common and normally closed contacts of S6001A and S6002A. The indicator lamps are lit as long as the console 28 VDC power supply is on and neither of the two source switches has been actuated; when either of them is actuated, the "NO DATA ON BUS" indicator lamps are out.

4. Switches S6001 and S6002 on the receiver site console are electrically interlocked. When either of them is actuated by depressing the plunger, the holding coil circuit of the other is interrupted. If both are accidentally actuated at the same time, they open each other's circuits; neither coil is energized, and only S6001 connects data from the radar site to the acquisition bus.

5. When the dual power supply on the receiver site console is first turned on, neither of the "SOURCE" switches is actuated. After either of them has been actuated, both of them can be de-energized only by turning off the dual power supply with switch S6201 (on the front of the dual power supply).

(d). SIGNAL STRENGTH AND AUDIO CIRCUITS (Figures 7-3 and 7-23)

1. Signal strength indications from the telemetry equipment on the site come into the receiver site acquisition data console on terminal board TB6003. (The connections between the telemetry equipment and the console are shown on figure 7-23.) These indications are in the form of d-c voltages whose magnitudes are indicative of the strength of the r-f signal inputs to the telemetry receivers. The d-c indications are applied through calibration potentiometers R6001 through R6004 and series voltage dropping resistors R6005 through R6008 to "SIGNAL STRENGTH" meters M6001 through M6004. The face of these meters is calibrated in microvolts on a non-linear scale. The calibration potentiometers are used to adjust the amount of resistance in the circuits so that with signals of known voltage amplitude applied to the inputs of the telemetry receivers, the signal strength meters indicate that signal magnitude. Hence, after proper calibration the meters on the console indicate the absolute magnitude of the signal being received by each of the four telemetry receivers. The telemetry receivers and associated equipment (and the console signal strength and audio circuits) are designated by the frequency on which they operate and the antenna from which they receive their signal. The letters "A" and "B" designate frequency, and the numbers "1" and "2" designate receiving antenna number 1 and receiving antenna number 2.

2. Audio signals from the site telemetry equipment come into the receiver site acquisition data console on terminal board TB6009 and through channel selector switch S6005 into terminal TB1-2 of the console audio amplifier. (Refer to paragraph 4-2. F. for information on the audio amplifier.) Switch S6005 selects one of the four audio signals for monitoring and at the same time lights a channel selector indicator lamp next to the "SIGNAL STRENGTH" meter which is associated with the

telemetry equipment which is the source of the monitored audio. The channel selector indicators, DS6035 through DS6038, provide a correlation between monitored audio and signal strength indication. The purpose of monitoring audio is to permit the operator to confirm that a signal strength indication is from an actual telemetry signal and not just noise. As shown by figures 7-3 and 7-23, the audio volume control, R6009, is located on the console outside of the audio amplifier itself. See figure 3-2 for the location of the volume control.

3. For manual tracking at the receiver site by means of received signal strength, the telemetry equipment is selected which provides the best signal strength indication and audio. With the receiving antenna which is connected to the selected telemetry equipment slaved to the acquisition bus, and the manual input connected to the bus, the acquisition data console operator turns the manual input handwheels and thereby remotely positions the selected receiving antenna for maximum signal strength indication. This action of course amounts to pointing the antenna at the capsule.

D. ACTIVE ACQUISITION AID

(1). GENERAL

(a). One of the problems associated with the use of narrow-beam, precision-tracking radars is the acquisition of a small, high-speed target. The problem is due simply to the fact that the target passes through the radar beam so quickly that the radar and/or operators have very little time in which to recognize the target and switch into automatic tracking. The problem is solved by the use of the active acquisition aid, which has a wide antenna pattern (20 degrees), but tracks with accuracy (within ±0.5 degrees) sufficient to point a narrow-beam radar at the target.

(b). The relative cones of coverage of the radar and the active acquisition aid are represented in figure 4-11. The active

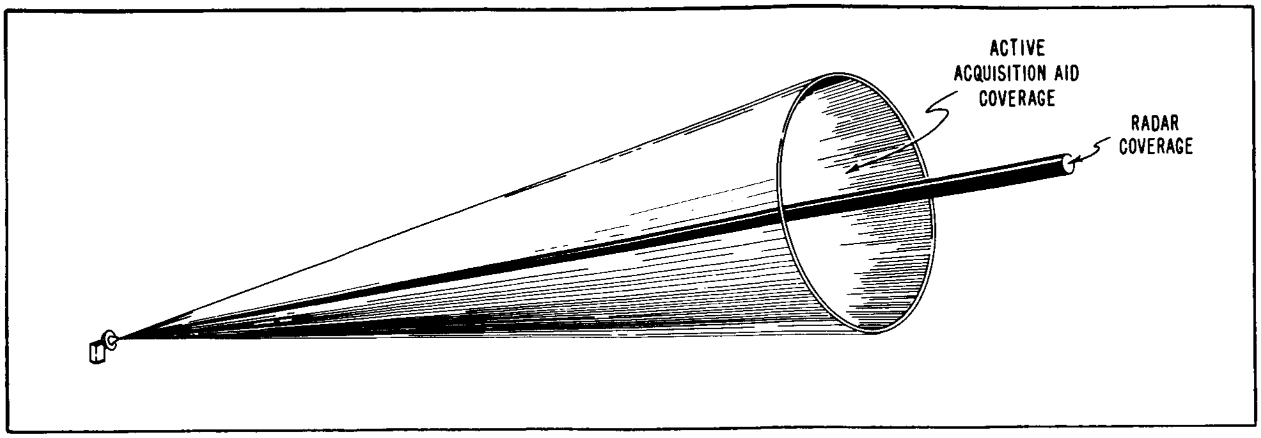


Figure 4-11. Relative Coverage by Active Acquisition Aid and Radar

acquisition aid cone of coverage on the illustration does not represent an actual beam since the active acquisition aid has no transmitter; instead, it represents a receiving antenna pattern. Because of its wide cone of coverage, the active acquisition aid does not require precise antenna pointing in order to acquire its target, the Mercury capsule. The antenna is pointed in accordance with the best data available. For initial acquisition, as the capsule comes over the radio horizon, this data is based on computations of the capsule's orbit. For re-acquisition in the event automatic tracking is lost during a pass of the capsule, the best data is in most cases simply an estimate based on the capsule's position when the track was lost. As soon as the capsule comes within its 20-degree cone of coverage, the active acquisition aid acquires an automatic track and steers itself to boresight; i.e., it points its antenna so that the capsule is in the center of its cone of coverage. Position data (capsule azimuth and elevation) is then put out by the active acquisition aid and at the radar site acquisition data console is switched onto the acquisition bus. The radars are slaved to this data and are therefore pointed at the capsule. The active acquisition aid continues to track the capsule and each radar remains slaved until it acquires the capsule and begins independent, automatic tracking. This, then, is the primary function of the active acquisition aid: to acquire and track the capsule in azimuth and elevation and provide data which enables the radars to acquire the capsule.

(d). The secondary function of the active acquisition aid is to provide pointing data to the non-tracking antennas on the site. After it acquires the capsule, the active acquisition aid continues automatic tracking until the capsule is out of range. The non-tracking antennas are normally slaved through the acquisition system to one of the radars, but before either radar acquires the capsule or when for any other reason data from the radars is not available, the non-tracking antennas are slaved to the active acquisition aid.

(2). BLOCK DIAGRAM DESCRIPTION (Figure 4-12)

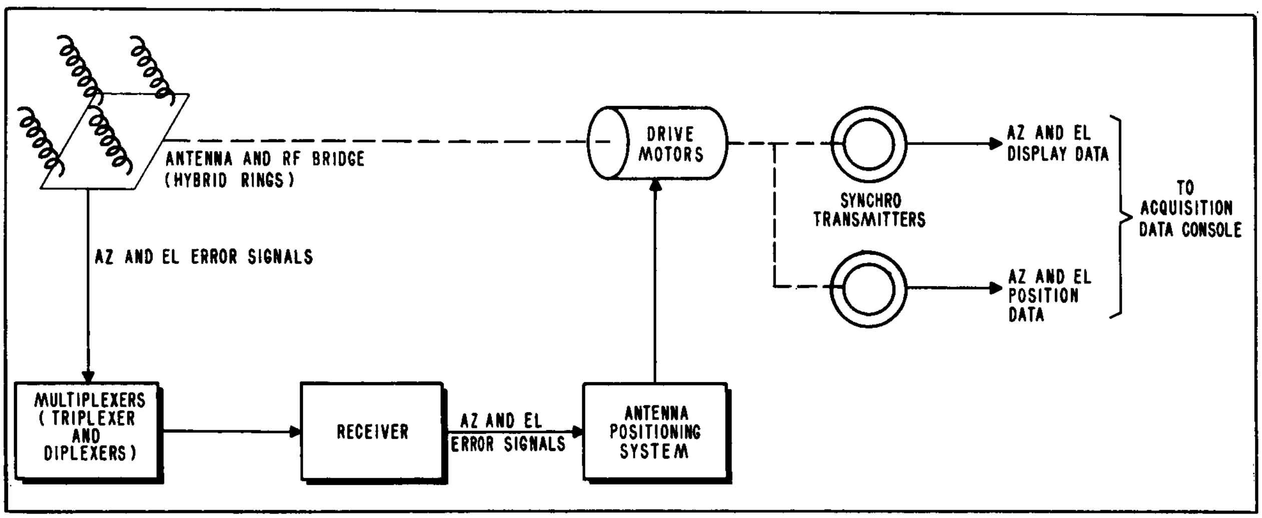


Figure 4-12. Active Acquisition Aid, Simplified Block Diagram

(a). The active acquisition aid quad-helix antenna receives two telemetry signals transmitted by the capsule. These signals at frequencies T1 and T2 (also designated frequencies A and B) are fed from the helical antenna elements to an r-f bridge composed of the four hybrid rings. For each frequency, three outputs from the r-f bridge are used. These outputs are reference signal (vectorial sum of the signals from the four antenna elements), a signal (azimuth error) which depends on the azimuth displacement of the antenna from boresight, and a signal (elevation error) which depends on the elevation displacement of the antenna from boresight. The derivation of the azimuth and elevation error signals is based on a phase comparison in the r-f bridge of the signals from the antenna elements. When the antenna is off boresight in azimuth, the signals from the two elements on the right side of the antenna differ in phase from the signals from the two elements on the left side; when the antenna is off boresight in elevation, the signals from the two top elements differ in phase from the signals from the two bottom elements. Comparison of these phases yields the error signals.

(b). The azimuth and elevation error signals and the reference signal are fed from the r-f bridge through the triplexer and diplexers, for frequency separation, to the receiver. The first and second r-f amplifiers and the first mixer and i-f amplifier of the receiver are in the RF housing unit. The balance of the receiver circuits are in the receiver cabinet. The receiver locks onto one or the other of the telemetry frequencies, as selected by switch.

(c). The output of the receiver consists of azimuth and elevation error signals to the antenna positioning system. The antenna positioning system comprises, in essence, electronic and electro-mechanical servo amplifiers and antenna drive motors. This system continuously positions the antenna for minimum, or null, error signals out of the receiver. Thus, the antenna is kept pointing at the target which is being tracked.

(d). Two pairs of synchro transmitters are mechanically coupled to the antenna. One of these pairs transmits antenna azimuth and elevation position data to the radar site acquisition data console for connection to the acquisition bus. The other pair transmits azimuth and elevation display data for display on the active acquisition aid control console and on the radar site acquisition data console. The position data transmitters provide the principal output of the active acquisition aid system; these transmitters are the means by which acquisition and tracking information is sent to other equipment.

(e). On the meter and switch panel of the control console, there are azimuth and elevation error meters which permit manual tracking with the active acquisition aid in the event that part of the automatic system is inoperative or when it is not desired to use fully automatic tracking. These meters indicate the amount and direction of antenna pointing error. (The errors indicated by the meters are essentially the same as those supplied to the antenna positioning system during fully automatic tracking.) For manual tracking with the error meters, the operator simply turns the manual handwheels on the control console to null the error indicated on the meters.

(f). Manual pointing of the antenna for maximum strength of received signals can be performed with the aid of the signal strength meter on the active acquisition aid control console. This meter indicates the strength of the signal in the sum channel of the active acquisition aid. For manual tracking by means of received signal strength, the operator simply turns the handwheels on the console for maximum signal strength as indicated on the meter.

E. SYNCHRO LINE AMPLIFIER

A block diagram of a synchro line amplifier and the manner in which it is connected into the system is shown in figure 4-13. The azimuth and elevation synchro transmitters shown on the illustration represent the transmitters at whatever source is connected to the synchro line amplifier, and the azimuth and elevation receivers on the illustration represent whatever receivers are connected to the synchro line amplifier. (For the transmitters and receivers connected to each synchro line amplifier, see the system block diagram, figure 4-1.) In both the azimuth and elevation channels, which are identical, the S2 stator windings are directly connected. The S1-S2 stator voltage and the S2-S3 stator voltage are amplified by amplifier elements with the S2 winding being the common (chassis ground) connection in both cases. (Each amplifier element consists of a voltage amplifier, a phase splitter, a push-pull cathode follower driver, and a push-pull power amplifier.) With this arrangement, a third amplifier element is not necessary for the S1-S3 voltage; the S1-S3 voltage is taken across the output of the two amplifier elements. The output of the amplifier elements in the synchro line amplifier is reversed 180 degrees in phase from the input. To compensate for this reversal, the R1 and R2 rotor leads are reversed between the synchro transmitters and the receivers, or, in some cases, the synchro receivers are electrically turned 180 degrees without interchanging the R1 and R2

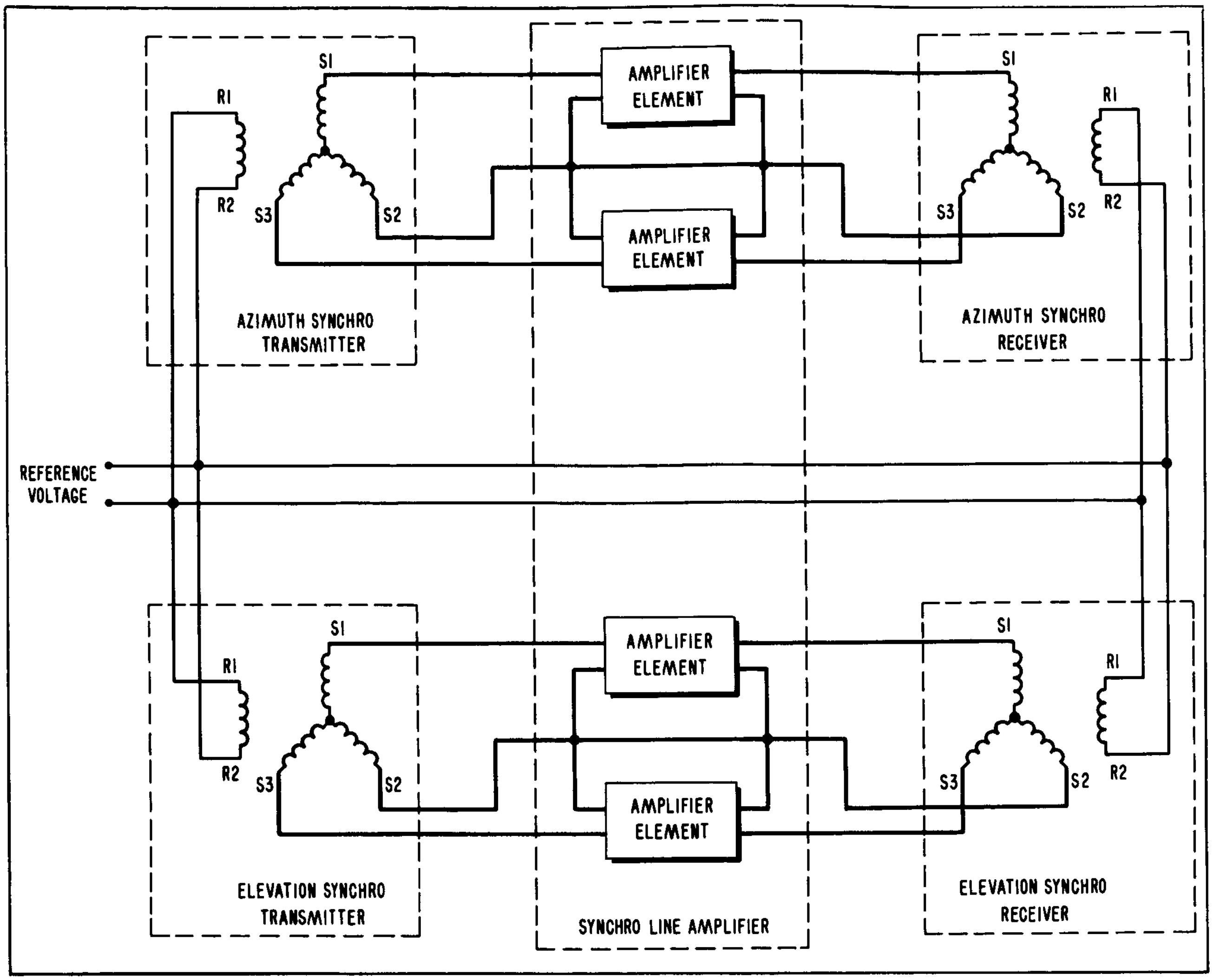


Figure 4-13. Synchro Line Amplifier, Block Diagram

connections. (Refer to Section V.) For a complete discussion of the theory of operation of the synchro line amplifiers, refer to the applicable equipment manual, listed in table 1-II.

F. AUDIO AMPLIFIER

(1). The audio amplifier, which forms part of the acquisition data console, uses conventional circuitry throughout. See figure 7-7. Input signals applied to TB1-2 (The TB1-3 input is not used) are coupled by input transformer T2 to the grid of voltage amplifier V2A. (As shown on figure 7-7, the primary of T2 consists of two series windings, which are connected by a jumper between T2 terminals 3 and 4. This connection provides a 600-ohm input impedance.) The output from the plate of V2A is coupled by capacitor C1 through TB1-6 to volume control potentiometer R6009 which is external to the amplifier. Signals from the volume control are connected through TB1-7 directly to voltage amplifier V2B and thence through coupling capacitor C2 to power amplifier V3. The output of V3 is applied through output transformer T3 either to phone jacks J1 and J2 or to the speaker LS1, as selected by "SPEAKER ON-OFF" switch S1. When switch S1 is off, terminals 3 and 8 (500-ohm impedance) of T3 are connected to the phone jacks, and terminals 3 and 4 (four-ohm impedance) are connected to resistor R8 and R12. These resistors impose a load on the low impedance winding of the output transformer, in parallel with the high impedance winding connected to the phone jacks.

(2). Primary power for the amplifier is supplied through "AMPLIFIER ON-OFF" switch S2 and fuse F1 to the power supply, which comprises transformer T1, full wave rectifier V1 and a filter network which consists of resistors R9 and R10, and capacitors C5, C6, and C7. Plate supply voltage for the output stage, V3, is taken from the power supply filter at the junction of resistors R9 and R10, and the supply voltage for the plates of V2 and the screen of V3 taken from the junction of R10 and bleeder R11.

G. SYNCHRO REMOTING SYSTEM

As was discussed in Section I, and in previous paragraphs in this section, each complete synchro remoting system consists of two transmitter-receivers. Each of the transmitter and receiver portions of a transmitter-receiver has two channels, one for azimuth data and the other for elevation data. Each channel of the system converts synchro data into a 10-bit digital code (gray code) using frequency multiplexed audio tones, transmits the encoded data over a voice-quality telephone line (three-kc bandwidth), and at the receiving end decodes the transmitted signal and synthesizes a synchro signal. A block diagram of one transmitter channel and one receiver channel of the system is shown in figure 4-14. A servo loop consisting of a control transformer, a servo amplifier, and a servo motor positions the shaft of the digital encoder in accordance with the synchro data input to the channel. (For a discussion of the principles of such a servo loop, refer to paragraph 4-2.I.) Ten tone oscillators, which have frequencies spaced 200 cps apart from 1100 to 2900 cps, are connected to wipers on the encoder. The encoder connects combinations of the 10 tones to a common line in accordance with a digital code which represents the angle

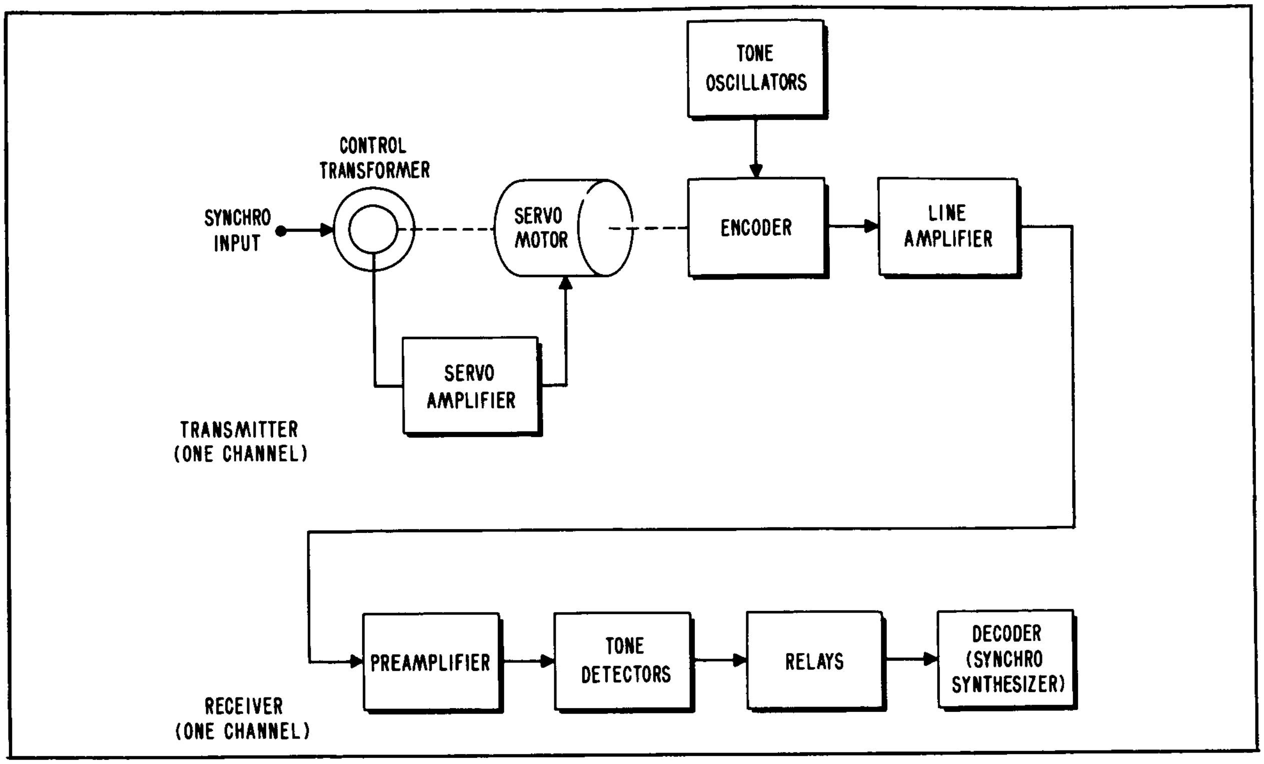


Figure 4-14. Synchro Remoting System, Block Diagram

of the encoder shaft. The composite-tone (multiplexed) output of the encoder is amplified and transmitted to the receiver. The received signal is amplified by a preamplifier and supplied to 10 tone detectors. Each of the detectors consists of an LC filter and two amplifier stages. The filter in each of the detectors is tuned to one of the audio frequencies used by the system. Each detector produces an output only when the tone, or frequency, to which its filter is tuned is present in the composite received signal. Each detector is connected to a relay, which is energized when the detector produces an output. Each of the 10 relays is thus energized or not energized in accordance with the on or off condition of the corresponding wiper in the transmitter encoder; hence, when considered together, the relay contacts by their open or closed condition contain a digital representation of the synchro input to the transmitter. The decoder consists of a special transformer with multiple windings. The 10 relays connect combinations of the transformer windings to produce a synthesized synchro signal which, within the limitation of system accuracy, is the same as the synchro signal supplied to the system transmitter. For a complete discussion of the theory of operation of the synchro remoting system, refer to the applicable equipment manual listed in table 1-II.

H. SYNCHROS

(1). TRANSMITTERS AND RECEIVERS

(a). A standard synchro transmitter or receiver such as is used in the acquisition system, may be considered as a single-phase transformer with a rotatable primary and a stationary, wye-wound secondary. Accordingly, the primary winding is called the rotor, and the secondary windings are called the stator. The two terminals of the rotor windings are designated R1 and R2, and the terminals of the three stator windings are designated S1, S2, and S3.

(b). A reference, or excitation voltage (115 VAC, 60 cycles for the synchros in the acquisition system) is applied to the rotor of a synchro. (See figure 4-15.) This reference voltage applied to the rotor of the synchro induces voltages in the stator windings. The magnitude of the voltage induced in a given stator winding depends on the angle which the rotor makes with that stator winding, and the phase angle of the voltage in a stator winding with respect to the rotor voltage is always zero or 180 degrees. The voltage in the windings of a synchro

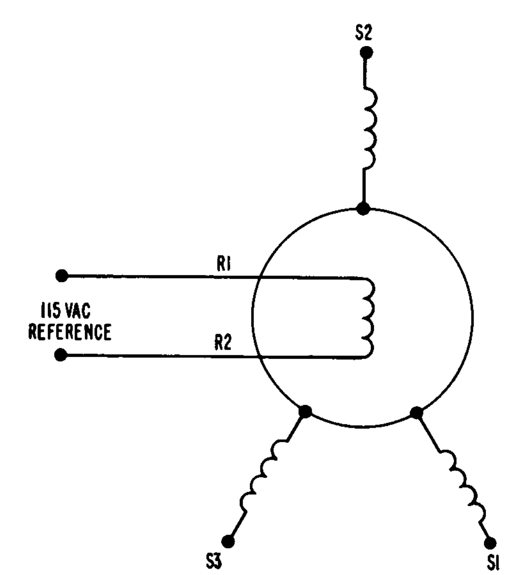


Figure 4-15. Synchro Transmitter and Receiver, Schematic Diagram

stator are shown in figure 4-16. The curves in the illustration are plots of the voltage magnitudes and phase against the angle of the rotor. The voltage across each stator winding (i.e., from the winding terminal to the common connection of the three windings) varies from 52 VAC (rms) of one phase polarity through zero to 52 VAC of the opposite phase polarity as the rotor is turned. Due to the way the rotor and stator windings are arranged on a synchro, these curves are sinusoidal. However, they should not be confused with time-graphs of sinusoidal voltages. All of the voltages in a synchro system are a-c, they are either in phase or 180 degrees out of phase with each other, and their effective (rms) values vary with the angle of the rotor, as shown on the illustration.

(c). In practice, no external connection is made to the common connection of the three stator windings, and the synchro system stator voltages are taken between the three pairs of windings: S2 and S1, S2 and S3, and S1 and S3. The voltage magnitude and phase between these pairs of windings is shown in figure 4-17 for varying rotor angles.

(d). The simplest form of synchro system consists of a transmitter and a receiver. A transmitter and a receiver which are suitable for use in the same system generally are electrically identical, but differ somewhat mechanically. The most notable mechanical difference is the use of a damper on the receiver in order to prevent it from oscillating. The transmitter, being mechanically coupled to an antenna or handwheel through a gear train, requires no damper. Hence, if mechanical coupling can be arranged, a receiver can be used as a transmitter, but a transmitter generally cannot be used as a receiver.

(e). The manner in which a synchro system works is illustrated in figures 4-18 and 4-19. The stator windings of the transmitter are connected to the corresponding windings on the receiver: S1 to S1, S2 to S2, and S3 to S3. The rotor windings of the transmitter and receiver are connected in parallel and are supplied by 115 VAC reference.

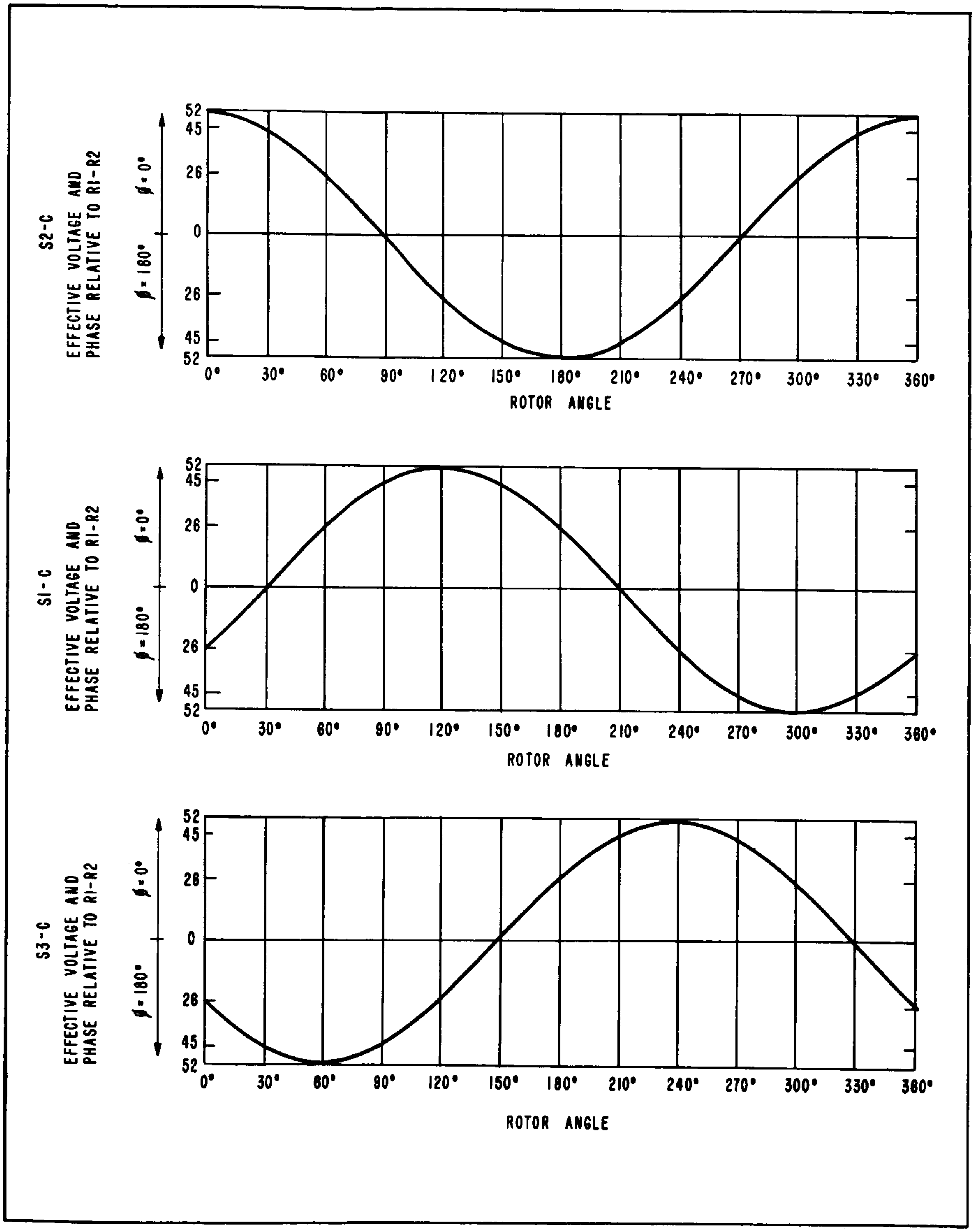


Figure 4-16. Voltages in Synchro Stator Windings

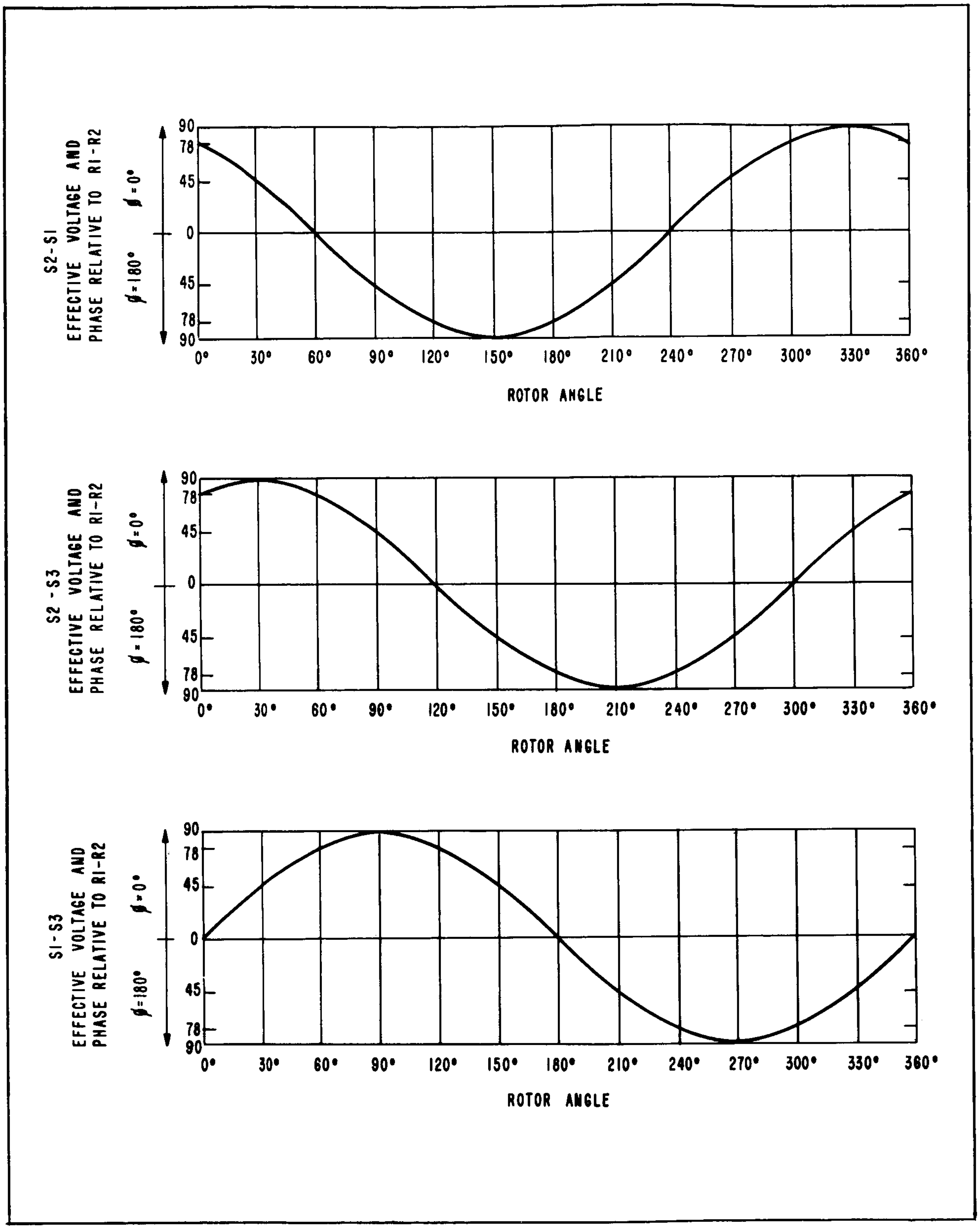


Figure 4-17. Voltages Between Synchro Stator Windings

Note

All of the rotor windings in a synchro system must be connected to a common reference voltage source. Otherwise, phase differences between voltage sources will cause inaccuracies in the system.

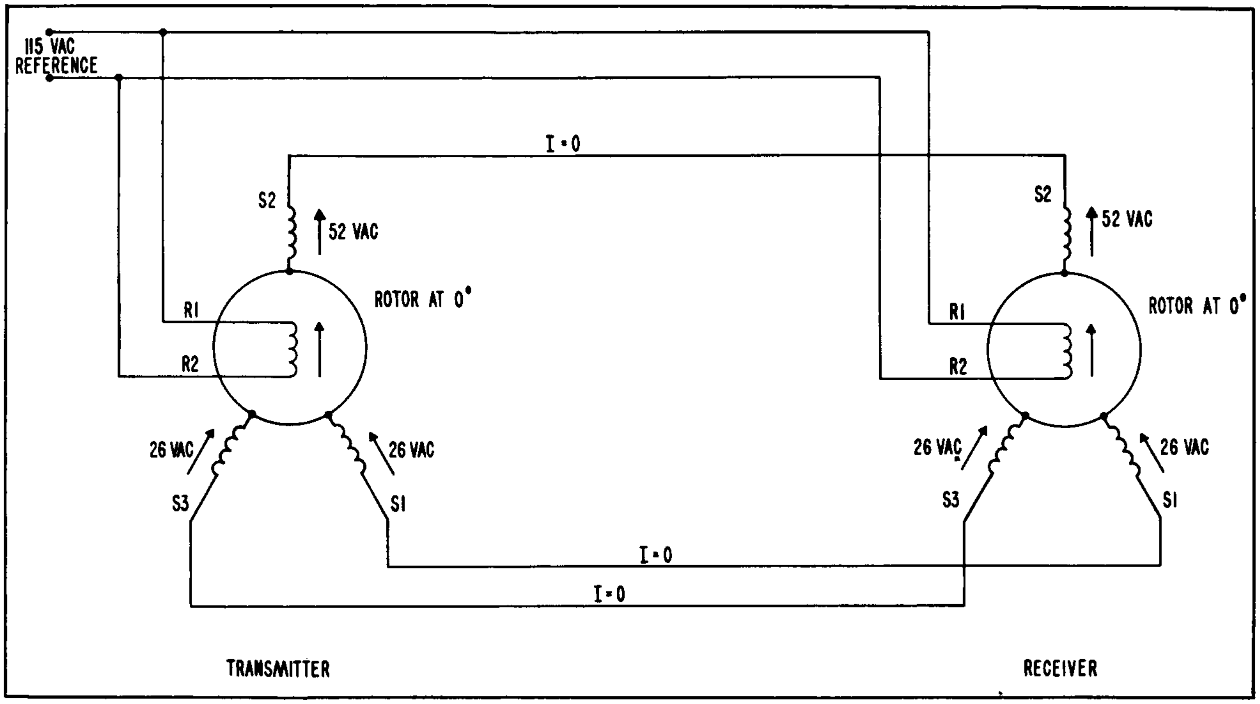


Figure 4-18. Simple Synchro System with Transmitter and Receiver Rotors at the Same Position, Schematic Diagram

With the reference voltage applied and both of the rotors at zero degrees, as shown in figure 4-18, voltages in the stator windings are 52 VAC for the S2 windings and 26 VAC for the S1 and S3 windings. The arrows on the illustration adjacent to the windings indicate relative instantaneous current direction (relative phase). As can be seen from figure 4-18, with both the transmitter and receiver rotors at the zero position, the magnitudes of the voltages induced in the stator windings of the transmitter and receiver are the same, and the phases are such that no current flows through the windings. With no current in the windings, no torque is developed and both synchros remain at rest. This condition of dynamic balance (voltages and phases such that no current flows in the stator windings) exists whenever, but only so long as, the rotors of the transmitter and receiver are at the same angular position.

(f). If the synchro receiver is held at one position and the transmitter turned to another position, unbalanced stator voltages are developed and current flows in the windings. An example of this condition is shown in figure 4-19. The rotor of the transmitter is turned to 30 degrees, inducing stator voltages of the magnitudes and relative phases

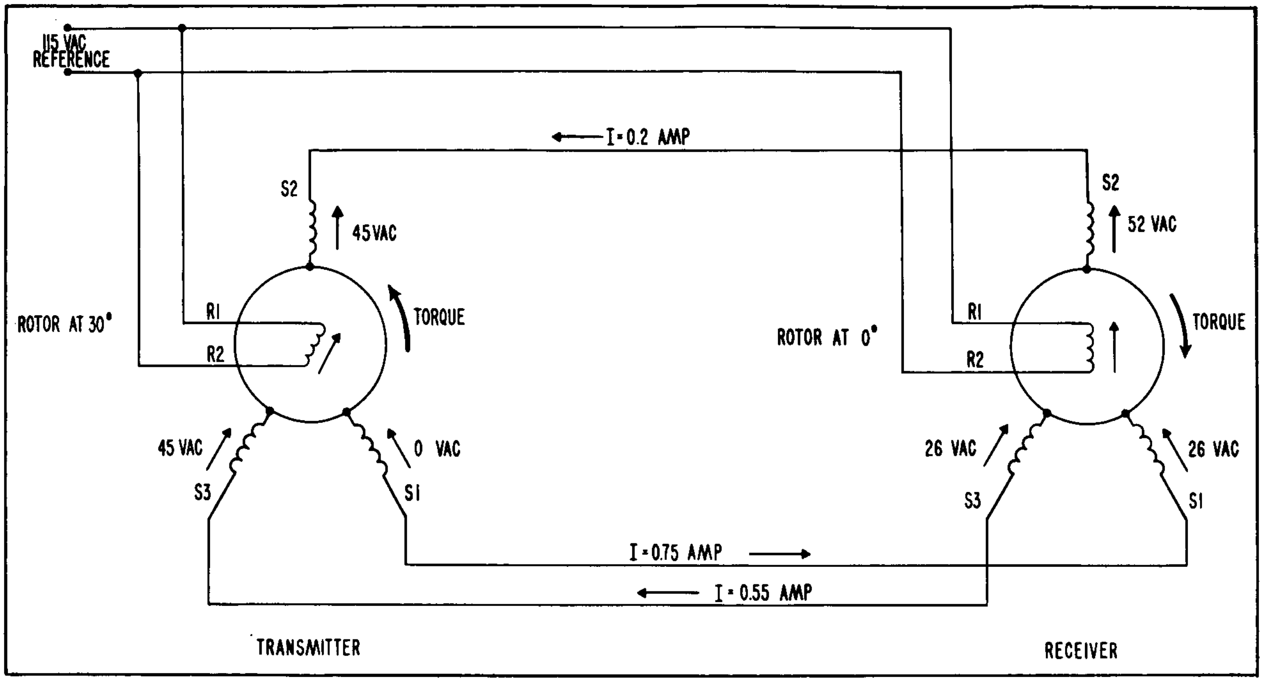


Figure 4-19. Simple Synchro System with Transmitter and Receiver Rotors at Different Positions, Schematic Diagram

as shown on the illustration. (For the magnitude and relative phase of the induced stator voltages at any position of the rotor, see figure 4-16.) The rotor of the receiver, however, is at a different position, zero degrees, and the voltages induced in its stator windings are different from those in the stator of the transmitter. Currents with the relative phases shown flow in the stator windings. The magnitudes indicated for the currents are typical values. These currents cause torque to be applied to the rotors of the synchros and both of the rotors try to turn. Under conditions shown on figure 4-19, the transmitter rotor will try to turn in a counterclockwise direction and the receiver rotor in a clockwise direction. The transmitter rotor, when it is mechanically coupled to an antenna or a handwheel, is not free to turn, but the receiver rotor is free to turn. Thus, the receiver rotor comes to dynamic rest. In the same manner, if the transmitter rotor is turned to some new position, the receiver rotor follows, the synchros used in the acquisition system have sufficient sensitivity that as long as reference voltage is applied and the units are operating normally, a receiver will always follow the transmitter to which it is connected within a small fraction of a degree; the receiver is always at virtually the same position as the transmitter, regardless of whether the transmitter is stationary or is being turned. Hence, a pointer or dial attached to the receiver rotor provides an indication of the angular position of the device—in most cases an antenna—to which the transmitter rotor is coupled.

(g). Either a single receiver or several receivers in parallel may be driven by a single transmitter. The acquisition system employs both of these arrangements.

(h). A variety of nomenclature is applied to synchros. The most common of these are listed and explained below:

1. Torque receiver (TR): a synchro receiver.
2. Torque transmitter (TX): a synchro transmitter which can drive a relatively large mechanical load (on the receiver or receivers connected to the transmitter).
3. Control transmitter (CX): a synchro transmitter which can drive only a relatively small mechanical load (on the receiver or receivers connected to the transmitter).

Note

Both torque transmitters and control transmitters are synchro transmitters as described in the previous paragraphs, and except for the amount of load they can drive, they are the same.

4. Synchro generator: a synchro transmitter.
5. Synchro motor: a synchro receiver.

6. Control transformer (CT): this device is described in the following paragraph.

7. Selsyn, autosyn: trade names for synchros.

(2). CONTROL TRANSFORMERS

(a). The control transformer is a type of synchro unit widely used in automatic control systems. Its function is to supply an a-c voltage whose magnitude and phase polarity depend on the difference between the angular position of its rotor and the rotor of the synchro transmitter which is connected to it. Control transformers are used in various places in the antenna positioning systems which are part of or are connected to the acquisition system.

(b). Control transformers are similar to synchro transmitters and receivers, but differ from them in several important respects:

1. The rotor winding of a control transformer is never connected to an a-c supply and therefore induces no voltage in the stator windings. As a result, the stator current is determined only by the impedance of the windings, which is high, and it is not appreciably affected by the rotor's position. (A matched set of delta-connected capacitors is connected across the stator leads near the control transformer. These capacitors correct the lagging power factor of control transformer coils and reduce the current drawn from the synchro transmitter.) Also, there is no appreciable current in the rotor, and the rotor does not tend to turn to any particular position when voltages are applied to the stator. The rotor of a control transformer is always turned by some mechanical device such as an antenna. (Or more specifically, by gearing between an antenna and the control transformer.)

2. The zero position of a control transformer is that at which the rotor is at right angles to the S2 stator winding. (See figure 4-20.) Note that this zero position differs by 90 degrees from that of a transmitter or receiver (figure 4-18).

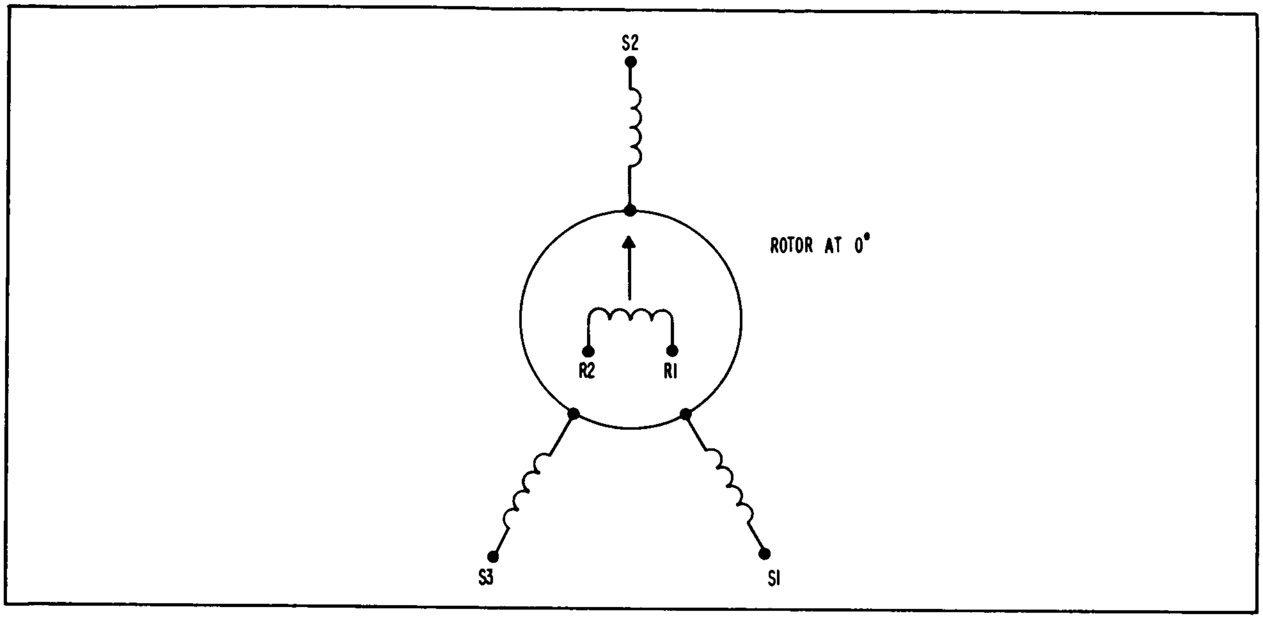


Figure 4-20. Control Transformer, Schematic Diagram

(c). The manner in which a control transformer is connected in a system is shown in figure 4-21. The stator windings of the control transformer are connected to the corresponding stator windings of a synchro transmitter. The rotor of the control transformer is usually connected to a servo amplifier. With a reference voltage (115 VAC) applied to the rotor of the transmitter, voltages are induced in the stator windings of the transmitter. These voltages are representative, by magnitude and phase polarity, of the angular position of the rotor. Since the stators of the control transformer and transmitter are connected, currents flow in the windings, and if the control transformer rotor is at any position except the same as or 180 degrees different from that of the transmitter rotor, voltage is induced in the control transformer rotor.

(d). The voltage induced in the control transformer rotor when it is at a position different from the transmitter rotor depends in magnitude and phase polarity on the angular difference between the two rotors. The voltage variation for 360 degrees of angular difference between the positions of the two rotors is shown on figure 4-22. Note

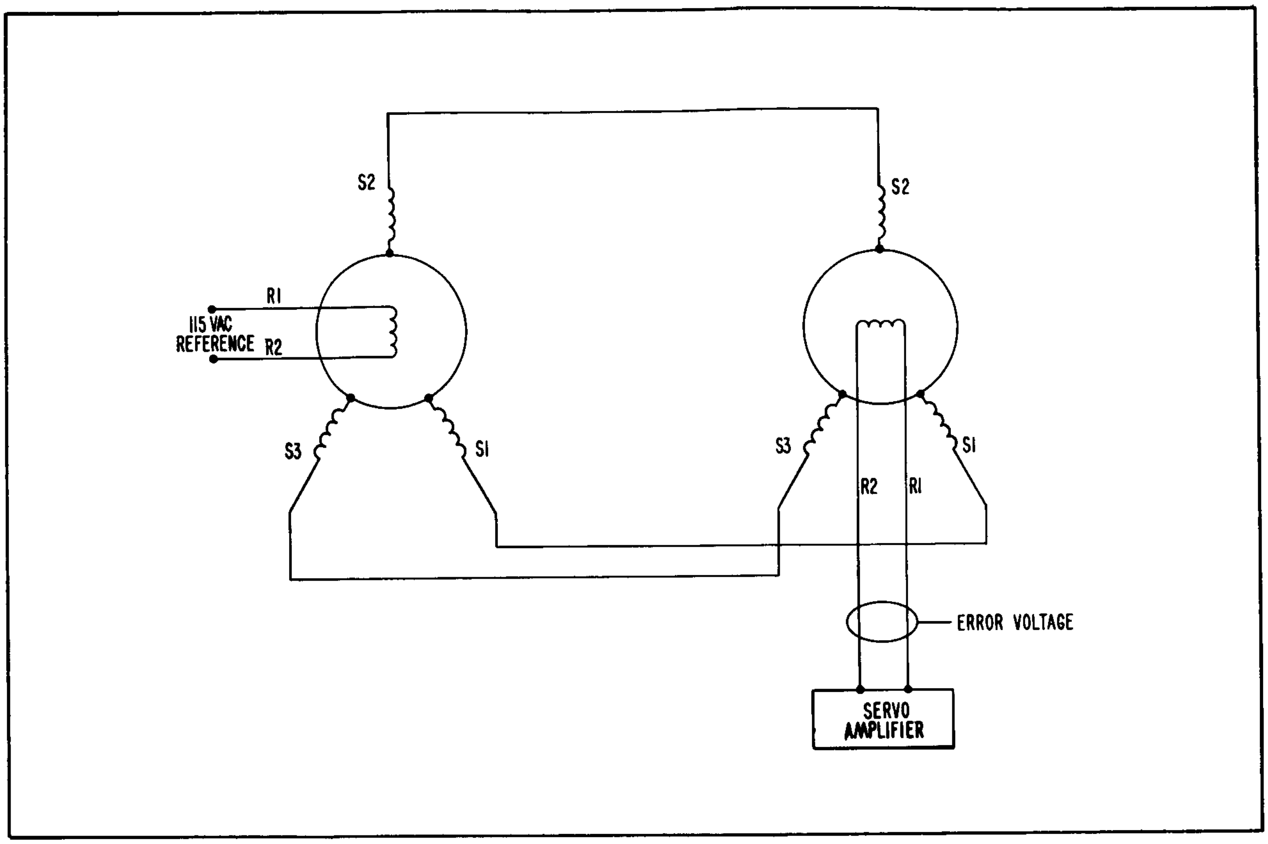


Figure 4-21. Control Transformer and Synchro Transmitter Connections, Schematic Diagram

that the rotor voltage has two null points: at positions which are zero and 180 degrees different from the position of the transmitter rotor. When the control transformer rotor is between zero and 180 degrees relative to the transmitter rotor (voltage curve above zero line on figure 4-22), the control transformer rotor voltage is of one phase; between 180 and 360 degrees (voltage curve below the line on figure 4-22), it is of the opposite phase.

(e). For a description of how control transformers are used, refer to paragraph 4-2. I.

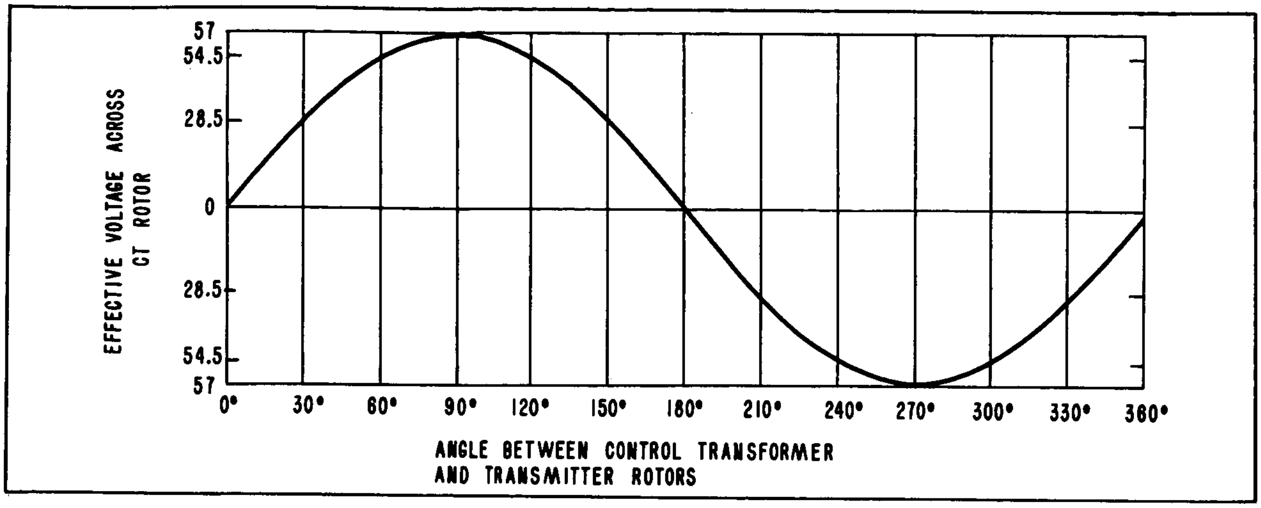


Figure 4-22. Voltage in Rotor Winding of Control Transformer

I. TYPICAL SERVO SYSTEMS UTILIZING SYNCHROS

In the acquisition system and the equipment associated with it there are a number of servo systems which utilize synchros. A simplified version of a servo system of this type is described in this paragraph in order to provide a basic understanding of how mechanical position data is converted to electrical form, transmitted over a distance, and converted back to mechanical form. Figure 4-23 illustrates such a system.

(1). The principal elements of the system are a mechanical input (the handwheel on figure 4-23), a mechanical/electrical converter (the synchro transmitter) and electrical/mechanical converter (the servo loop consisting of the control transformer, the servo amplifier, and the servo motor), and a mechanical output, or load (the antenna).

(2). The output of the synchro transmitter is a function of the position of its rotor, which is mechanically coupled to the handwheel. The output of the synchro transmitter is connected to the control transformer, whose rotor may or may not be at the same angular position as that of the transmitter. (Refer to paragraph 4-2.H. for a description of the operation of synchro transmitters and control transformers.) When the control transformer rotor is not at the same position as the rotor of the transmitter, a voltage is developed in the control transformer rotor windings. The

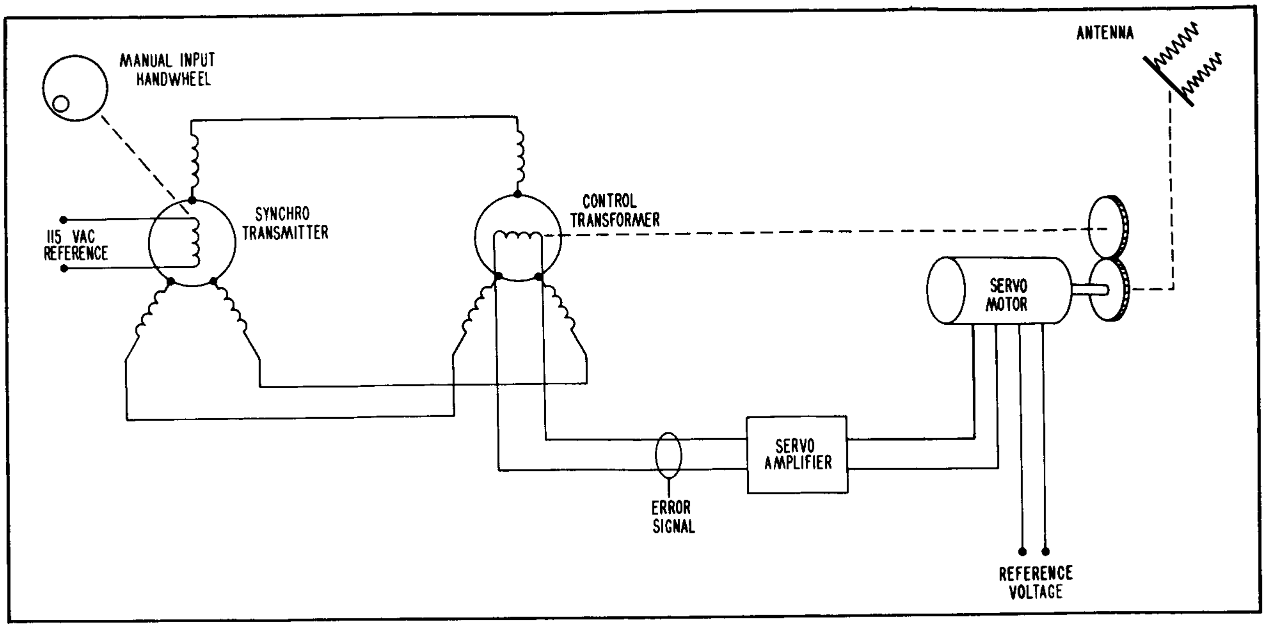


Figure 4-23. Typical Servo System Utilizing Synchros, Simplified Schematic Diagram

magnitude and phase polarity of this voltage depend on the angular difference between the positions of the two rotors. This voltage, the error signal of the servo loop, is applied to the servo amplifier, where it is amplified and applied to the variable-phase field winding of a two-phase motor. A reference voltage is applied to the fixed-phase field of the rotor. The direction of rotation of the motor depends on the phase of the error signal (relative to the reference voltage), and the speed of rotation of the motor depends on the magnitude of the error signal. When no error signal is applied, the motor does not rotate. The motor armature is coupled through gearing to the rotor of the control transformer and to the mechanical load, in this case an antenna. The gearing and phase of signals in the servo loop are so arranged that whenever there is an error signal developed across the rotor of the control transformer, the motor turns in the direction which results in a reduction of the magnitude of the error. Stated another way, the motor drives the rotor of the control transformer so that it is always at very nearly the same position as the rotor of the synchro transmitter. Since the antenna is also driven by the motor, it too is kept at virtually the same position as the transmitter rotor. Thus, the antenna follows the handwheel which turns the synchro transmitter rotor.

(3). The servo systems actually used in the acquisition system and associated equipment are generally more elaborate than that just described, but the principal elements of the systems are the same. For instance, the active acquisition aid uses an amplidyne and a d-c servo motor in each channel of its antenna positioning system. The d-c servo motor, however, has exactly the same basic function as the two-phase, a-c motor on figure 4-23, and the amplidyne is in its function simply an additional two-stage servo amplifier.

SECTION V
SYSTEM MAINTENANCE

5-1. GENERAL

This section includes information, instructions and procedures for preventive maintenance, trouble shooting, adjustments and repair, lubrication, special tools, and test equipment. In the majority of cases, detailed information is given only for the acquisition data consoles and their components; for other equipment in the system, system-level and general information is given. For detailed information on the other equipment in the system, refer to the applicable equipment manuals, listed in table 1-II.

WARNING

Antenna drive power cutoff switches and warning lights are mounted below the platforms of the active acquisition aid, both of the receiving antennas, and the transmitting antenna. (Refer to Section II for the location of the switches.) When drive power is applied to the pedestal, the warning light is lit. The switch should be turned off (thus removing drive power from the pedestal) before going onto the antenna platform for maintenance or repair. For a schematic diagram of the active acquisition aid antenna safety circuit, which includes a cutoff switch and warning light, see figure 7-20.

5-2. PREVENTIVE MAINTENANCE

A. PREVENTIVE MAINTENANCE SCHEDULE

Table 5-I outlines the preventive maintenance procedures which are to be performed on all of the equipment in the acquisition system. Detailed procedures are discussed in paragraph 5-2.B. and the equipment manuals.

TABLE 5-I. PREVENTIVE MAINTENANCE SCHEDULE

Equipment	Maintenance To Be Performed	Refer To
	DAILY	
Active Acquisition Aid	Check cover plates on pedestal for watertightness.	Equipment manual
	Check all strip heaters for proper operation.	Equipment manual
	Check azimuth and elevation limit switches for proper operation.	Equipment manual
	Operate the pedestal both in azimuth and elevation for several minutes in order to keep the gearing well lubricated.	–
	WEEKLY	
All	Check for corrosion of painted and plated surfaces. Clean and resurface all corroded areas.	Paragraphs 5-2.B.(1). and (2).
	Check mechanical condition of switches to see that they are not loose or sluggish in their action.	–
	Replace any that appear likely to become defective.	–
All except Acquisition Data Consoles	Check the lamps or bulbs in all indicators. Replace any that are burned out.	Equipment manuals
Acquisition Data Consoles	Check and replace any burned out lamps in the 28 VDC power supply indicators.	Paragraph 3-2.B.
	Check and replace any burned out lamps in the source switch indicators.	Paragraph 3-2.D. and E.
	Check and replace any burned out lamps in all of the indicators not covered by the previous two steps.	Paragraph 3-5.A.
Active Acquisition Aid.	Check for the presence of water in the azimuth oil sump.	Equipment manual
	Check for the presence of water in the elevation gear compartment.	Equipment manual
	Check the oil level in the azimuth oil reservoir.	Equipment manual

TABLE 5-I. PREVENTIVE MAINTENANCE SCHEDULE (Cont.)

Equipment	Maintenance To Be Performed	Refer To
	MONTHLY	
All	Perform general cleaning as necessary. Wipe off, vacuum off, or blow out dust, dirt and sand. Clean dial plates (glass) on synchro displays.	–
	Check and correct as necessary the general condition of equipment. Check cables and wiring for worn or frayed insulation, check connectors to see that they are free from corrosion and are tight, and check terminal board connections for tightness.	– –
Active Acquisition Aid	Check the operation of the azimuth oil pump.	Equipment manual
	Check the oil level in the elevation oil reservoir.	Equipment manual
	Check the cleanliness of the lubricants in the antenna control unit.	Equipment manual
	Check the azimuth and elevation drive motor breakaway currents.	Equipment manual
	Check the conditions, placement, and dress of cables which wrap as the pedestal turns.	Equipment manual
	BIMONTHLY	
Active Acquisition Aid	Check the operation of the elevation oil pump.	Equipment manual
	Check the azimuth and elevation amplidyne and drive motor brushes and commutators.	Equipment manual
	Check the amount of backlash in the pedestal drive gearing.	Equipment manual
	SEMI-ANNUALLY	
Active Acquisition Aid	Check the mechanical friction of the pedestal (torque required for pedestal azimuth and elevation movement).	Equipment manual

TABLE 5-I. PREVENTIVE MAINTENANCE SCHEDULE (Cont.)

Equipment	Maintenance To Be Performed	Refer To
	SEMI-ANNUALLY (Cont.)	
Synchro Remoting System Units	Clean the intake and exhaust air filters with soap and water and apply new, thin film of oil.	—
	YEARLY	
Active Acquisition Aid	Disassemble azimuth and elevation amplidynes and clean and lubricate bearings and air circulating system.	Equipment manual
	Disassemble azimuth and elevation drive motors and check the condition of the bearings.	Equipment manual

B. PREVENTIVE MAINTENANCE PROCEDURES

(1). PAINTED SURFACES

Painted surfaces which have corroded should be sanded to remove all of the corroded material and then painted with a color which matches the original. If matching paint is not available apply any available paint. When matching paint is obtained, paint non-matching areas for the sake of appearance.

(2). PLATED SURFACES

Corrosion of plated surfaces (cadmium, nickel or other) should be removed with sandpaper or emery cloth and sprayed or brushed with a clear lacquer. If a clear lacquer is not available, the corroded areas should be painted to prevent further corrosion until lacquer can be obtained.

5-3. TROUBLE SHOOTING

This paragraph provides information to aid in the isolation and correction of troubles in the acquisition system. It is concerned primarily with those malfunctions which affect the transmission of acquisition information; for information on a malfunction which affects only an individual piece of data source or data-using equipment, refer to the applicable equipment manual. Since the d-c indication and synchro portions of the acquisition system are essentially independent of one another, they are treated separately in the following discussions.

A. D-C INDICATIONS

The d-c indication circuits in the acquisition system are simple and straightforward and should pose little difficulty in trouble shooting. When a d-c indicator fails to operate properly, refer to the diagrams in Section VII (both the individual equipment schematics and the interconnecting circuit schematics) and to the applicable portions of paragraph 5-4 for information on isolating and ascertaining the source of trouble. The source of the trouble will in most instances be obvious on examination of the circuits involved. For information on inter-equipment wiring, refer to Section II, and for information on the internal wiring of equipment other than the acquisition data console, refer to the applicable equipment manual.

B. SYNCHROS

This paragraph comprises three sections: criteria for distinguishing actual troubles (requiring repair or replacement to correct them) from those malfunctions which can be corrected by adjustment; system trouble analysis, and circuit trouble analysis. The material on system trouble analysis provides information to aid in isolating the trouble to a particular circuit, or portion of the system. The material on circuit trouble analysis will aid in further isolating and determining the exact nature of the trouble. Both the system and circuit trouble analyses are concerned with actual troubles, not misadjustments. For synchro adjustment procedures, refer to paragraph 5-4.B.

(1). CRITERIA FOR DISTINGUISHING TROUBLE FROM MISADJUSTMENT

A synchro device is not operating properly when it does not accurately, rapidly and smoothly transmit or follow the angular information which is fed into it. If a synchro has an error in the information it puts out, but the error is small and essentially constant and the output of the synchro follows the input smoothly and rapidly, the cause of the improper operation is most likely misadjustment. (For a transmitter the input is mechanical and the output is electrical. For a receiver the input is electrical and the output mechanical. For a control transformer there are two inputs, one electrical and one mechanical, and one output, electrical.) If the synchro follows the input but with changing error, does not follow the input, spins, oscillates, hunts, follows erratically, has a large error (about 60 degrees or more), hums, overheats, or exhibits a combination of these or similar symptoms, the cause is most likely an actual trouble, either in the synchro being observed, another synchro connected to it, or the circuits between the two. (Improper adjustment of a synchro line amplifier, however, will cause a varying error in the system which is not due to an actual trouble. The peak value of such error is dependent on the amount of amplifier output imbalance.)

(2). SYSTEM TROUBLE ANALYSIS

Trouble shooting of the synchros in the acquisition system requires a thorough knowledge of the basic principles of synchros and the particular way in which they are used in the system. (Refer to Section IV.) With this knowledge it should be evident from the pertinent schematics, especially figure 5-8 and the interconnecting circuit schematics in section VII, what the possible causes are for any given trouble. However, keep the following points in mind:

(a). A defective synchro can degrade the performance or cause abnormal operation of any or all synchros which are connected directly to it; for instance, where two receivers (or a receiver and a control transformer) are wired in parallel, a defect in one of them may cause abnormal operation of both. In cases where several synchros have abnormal operation, it will help in isolating the trouble to disconnect, one at a time, each of those involved to see which is affecting the operation of the others.

(b). Outside of the synchro remoting systems, the reference voltage (rotor) circuits are virtually the only circuits the azimuth and elevation channels have in common. If abnormal operation shows up in both azimuth and elevation channels in a portion of the acquisition system, look for trouble in the reference voltage circuits.

(c). Troubles that show up just after installation or replacement of synchro units are most likely due to incorrect wiring connections, not to defective units.

(d). When a trouble occurs, be sure to check all connecting circuits very thoroughly. Synchros themselves, although delicate instruments, are generally very reliable and trouble-free devices.

(3). CIRCUIT TROUBLE ANALYSIS

Once it has been determined that the source of trouble is in a particular circuit or portion of the system, circuit trouble analysis may be performed by one or a combination of the following means:

(a). Use of the synchro trouble shooting chart, figure 5-1: This chart graphically shows the symptoms and causes of most of the common synchro troubles, including incorrect wiring connections.

(b). Checks of connecting circuits: All of the circuits between synchros in a malfunctioning portion of the system should be checked in accordance with the applicable portions of paragraph 5-4 and the applicable equipment manuals. See also the interconnecting circuit diagrams in section VII.

(c). Synchro voltage checks: In some instances it may not be possible to turn the suspected synchros as is necessary when using figure 5-1. In such instances the synchro voltages can be checked. Transmitter and receiver rotor voltage should always be 115 VAC.

Transmitter, receiver and control transformer stator voltages should be as shown by the curves of figures 4-16. Control transformer rotor voltage should be as shown in figure 4-22.

5-4. ADJUSTMENTS AND REPAIR

A. GENERAL

This paragraph describes, on an individual basis, adjustment and repair procedures for synchros, the 28 VDC power supply, relays, and switch and indicator assemblies. Also described are adjustment procedures for the synchro line amplifier. For detailed information on other components of the acquisition system, see the applicable equipment manuals. The repair procedures given here are based on the assumption that a particular component, such as a relay, switch or synchro, is known or suspected to be malfunctioning. The procedures are for the isolation and correction of the specific cause of trouble. For general, or system, trouble shooting procedures, see paragraph 5-3.

B. SYNCHRO ALIGNMENT

(1). GENERAL

(a). This paragraph describes procedures for alignment and zeroing of synchro transmitters, receivers, and control transformers individually and while operating in a system. Also described are procedures for 180-degree reversal of synchro receivers.

(b). In a general sense, "zeroing" a synchro means adjusting it mechanically so that it will work properly in a system with one or more other synchros. Specifically, "zeroing" means aligning the mechanical and electrical zero positions of a synchro. Mechanical zero of a synchro is defined as the rotor position at which the mechanical device coupled to the synchro is at its zero position. For instance, a synchro transmitter coupled to the elevation drive of an antenna is at mechanical zero when the antenna is at zero degrees elevation; and a synchro receiver driving an azimuth indicator is at mechanical zero when the indicator pointer or dial reading is zero degrees azimuth. Electrical zero of a synchro is

IF UNITS HUM AND GET HOT,
FIRST BE SURE THE RECEIVER IS NOT JAMMED MECHANICALLY.
THEN TURN THE TRANSMITTER SMOOTHLY IN ONE DIRECTION AND SEE HOW THE MOTOR ACTS:

IF:	IF:	IF:	IF:
UNITS HUM AT ALL TRANSMITTER SETTINGS; ONE UNIT GETS HOT; RECEIVER TURNS SMOOTHLY IN THE RIGHT DIRECTION, BUT READS WRONG;	UNITS HUM AT ALL TRANSMITTER SETTINGS EXCEPT TWO OPPOSITE ONES; BOTH UNITS GET HOT; RECEIVER STAYS ON ONE READING HALF THE TIME, THEN SWINGS ABRUPTLY TO THE OPPOSITE ONE, OR OSCILLATES OR SPINS;	UNITS HUM ONLY OCCASIONALLY AT TWO OPPOSITE TRANSMITTER SETTINGS; BOTH UNITS GET WARM; RECEIVER TURNS SMOOTHLY IN ONE DIRECTION, THEN REVERSES AND TURNS THE OTHER WAY;	UNITS DO NOT GET HOT, BUT RECEIVER READS WRONG OR TURNS BACKWARD, FOLLOWING THE TRANSMITTER SMOOTHLY;
ROTOR CIRCUIT IS OPEN OR SHORTED (SEE CHART A)	STATOR CIRCUIT IS SHORTED (SEE CHART B)	STATOR CIRCUIT IS OPEN (SEE CHART C)	THE WIRING BETWEEN THE ROTORS OR THE STATORS IS MIXED UP, OR UNITS ARE NOT ZEROED (SEE CHART D AND E)

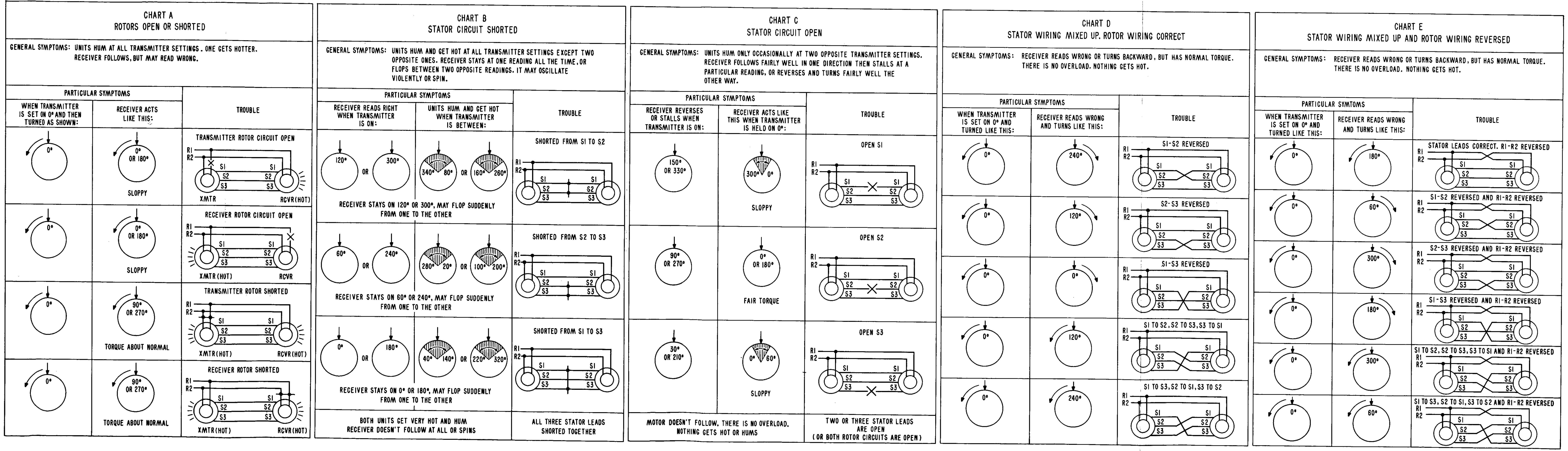


Figure 5-1. Synchro Troubles and Symptoms

defined as the position of the rotor when rated voltage is applied to the rotor, when there is no voltage difference between S1 and S3, and when rated voltage is applied between S2 and S1-S3 in such a way that the voltage at S2 (measured with respect to S1-S3) is in phase with the voltage at R1 (measured with respect to R2). The applied voltages and the rotor position at electrical zero are shown in figure 5-2. The voltages shown are the rated values for the synchros used in the acquisition system. For purposes of definition, the arrangement shown in figure 5-2 applies both to synchro transmitters and receivers, and it is actually used for zeroing receivers. However, since synchro transmitters in operating position are not free to turn, a more convenient zeroing procedure is described below. The electrical zero position of a control transformer is as described in paragraph 4-2.H.(2). and shown in figure 4-20.

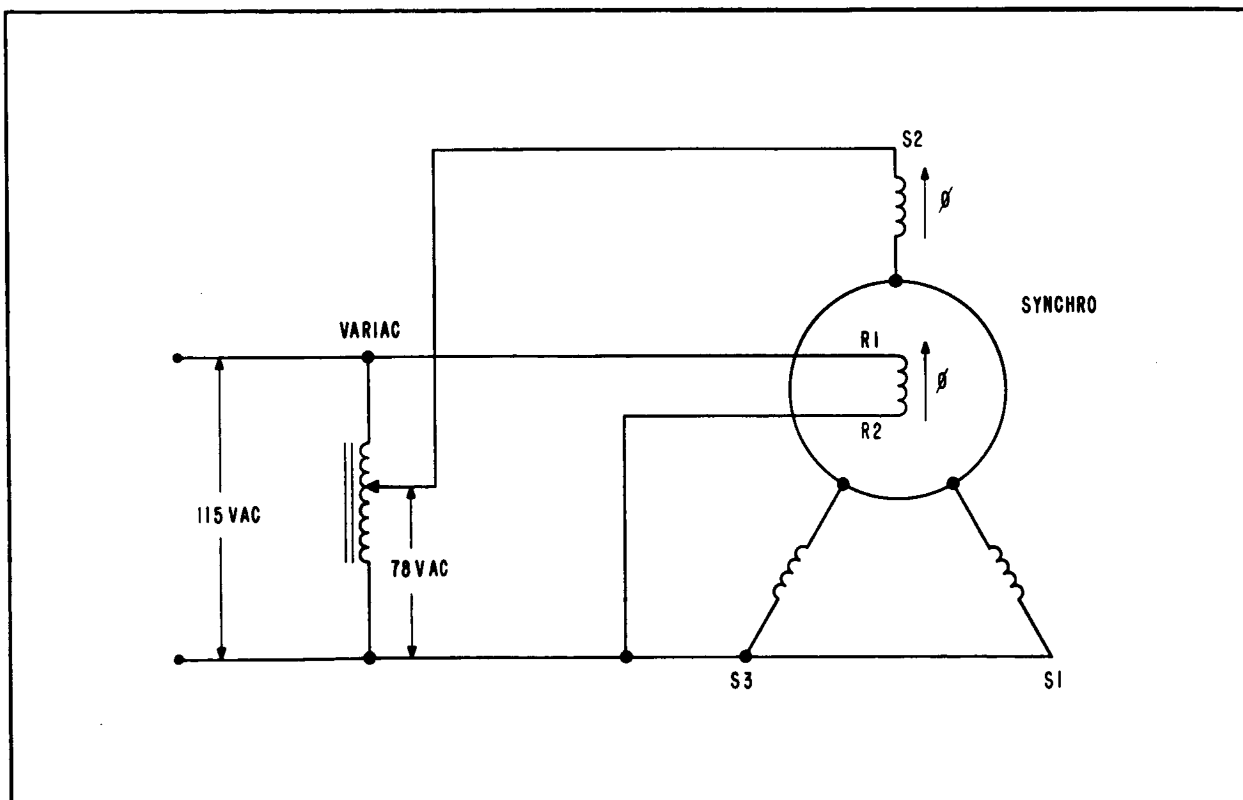


Figure 5-2. Conditions at Electrical Zero of a Synchro

(c). Certain of the synchro receivers used in the acquisition system require special procedures for zeroing. The requirement for special procedures derives from the facts that the R2 and S2 windings are internally connected in all synchros on the acquisition data console, that the S2 winding of all synchros connected to a synchro line amplifier is grounded within the amplifier, and that a synchro line amplifier reverses the phase of all synchro stator voltages which pass through it. Hence, with normal connections, synchro receivers connected to a line amplifier would give readings 180 degrees different from what they should; and the usual procedure for correcting a reverse synchro reading (interchanging the R1 and R2 connections) cannot be followed in all cases as it would result in a direct short circuit of the 115 VAC synchro reference voltage. The procedures given below of course take these conditions into account and except where noted are applicable to all synchros connected to the acquisition system.

(d). The procedures that follow comprise four sections; one for individual zeroing of transmitters, one for individual zeroing of receivers, one for individual zeroing of control transformers, and one for in-system alignment of transmitters and receivers. The first three sections apply, with some exceptions as noted, to any individual synchro transmitter, receiver or control transformer, in the acquisition system.

(2). SYNCHRO TRANSMITTERS

The following are two procedures for zeroing synchro transmitters. The simplified procedure should be used when, but only when, the approximate electrical zero position of the transmitter is known. The reason for this restriction is that the simplified procedure is ambiguous, i.e., the null voltage, for which the synchro is adjusted in the simplified procedure, occurs at two positions, electrical zero and 180 degrees. The complete procedure allows the approximate position of electrical zero to be determined. Normally, it is not necessary to follow the complete procedure. Once the transmitter has been installed and is operating properly, the transmitter can be set approximately to electrical zero simply by setting the device to which it is mechanically coupled to zero azimuth or elevation.

(a). **TRANSMITTER ZEROING PROCEDURE - COMPLETE**

1. Set the device to which the synchro is mechanically coupled to its zero-degree position (azimuth or elevation).

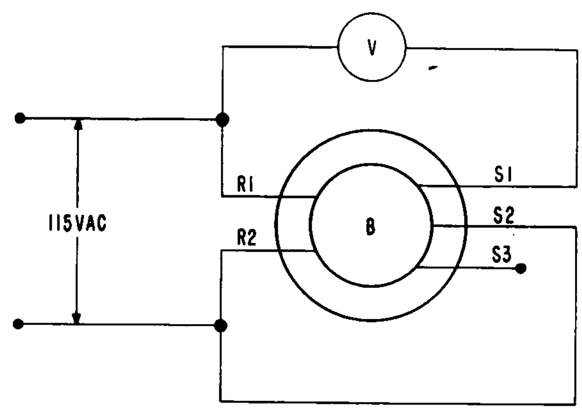
2. Turn off reference voltage to the synchro (115 VAC).

3. Disconnect the stator leads (S1, S2, S3) from the synchro.

4. Connect a jumper between synchro terminals R2 and S2 and connect a voltmeter (Hewlett-Packard 400D, 300 volt scale) between terminals R1 and S1. (See figure 5-3.)

CAUTION

Before connecting the jumper between R2 and S2, make sure that the synchro has no internal jumpers which, when the external jumper is connected, would result in a short circuit of the 115 VAC power.



B: SYNCHRO TRANSMITTER
V: HEWLETT-PACKARD 400D AC VTVM

MAKE CONNECTIONS AND APPLY POWER AS SHOWN

APPROXIMATE METER READINGS:

NEAR ELECTRICAL ZERO POSITION - 193 VAC
NEAR ELECTRICAL 180-DEGREE POSITION - 37 VAC

Figure 5-3. Method of Locating Approximate Position of Synchro Transmitter Electrical Zero

5. Apply 115 VAC to the rotor windings (R1 and R2) of the synchro:

a. If the meter reading is approximately 193 volts, the synchro is near electrical zero. Proceed with the simplified zeroing procedure below.

b. If the meter reading is approximately 37 volts, the synchro is near electrical 180 degrees. Turn off the 115 VAC reference, loosen the screws which hold the case, and turn the case of the synchro halfway around, so that the meter reading is approximately 193 volts. Then proceed with the simplified zeroing procedure below.

c. If the meter reading is something roughly midway between 37 and 193 volts, the synchro is not near either zero or 180 degrees. Proceed with the simplified zeroing procedure to set the synchro near zero or 180 degrees. Then repeat the complete zeroing procedure.

(b). TRANSMITTER ZEROING PROCEDURE - SIMPLIFIED

1. Set the device to which the synchro is mechanically coupled to its zero-degree position (azimuth or elevation).

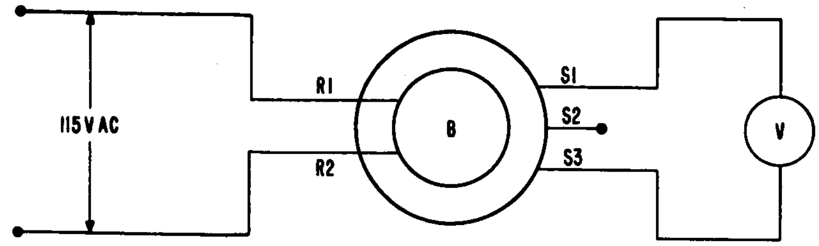
Note

See paragraph 5-4.B.(2). for restrictions on the use of this procedure.

2. Turn off reference voltage (115 VAC) to the synchro.

3. Disconnect stator leads (S1, S2, S3) from the synchro.

4. Connect a voltmeter (Hewlett-Packard 400D) between synchro terminals S1 and S3. (See figure 5-4.) To protect the meter, set it initially on the 100-volt scale. As lower voltage readings are obtained during the following steps of the zeroing procedure, set the meter to successively lower scales.



B: SYNCHRO TRANSMITTER
V: HEWLETT-PACKARD 400D AC VTVM

MAKE CONNECTIONS AND APPLY POWER AS SHOWN.

ROTATE CASE FOR MINIMUM READING ON METER (MINIMUM READING SHOULD BE ABOUT 0.1 VOLT)

Figure 5-4. Method of Zeroing Synchro Transmitter

5. Loosen the screws which hold the case of the synchro so that the case is free to turn.

6. Apply 115 VAC to the rotor windings (R1 and R2) of the synchro.

7. Turn the case of the synchro in the direction which results in a decreasing meter reading. When a very low voltage reading is obtained, rotate the case of the synchro back and forth to locate the position of null voltage on the meter. (Null voltage should be about 0.1 volt.) This position is the electrical zero of the synchro.

8. With the synchro set at electrical zero, tighten the screws which hold the case in place.

9. Turn off the reference voltage (115 VAC) and reconnect stator leads (S1, S2, S3).

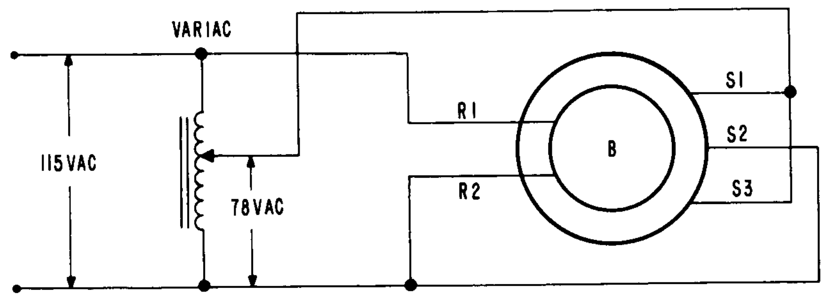
(3). <u>SYNCHRO RECEIVERS</u>

This paragraph describes procedures for zeroing and for reversing synchro receivers. Two procedures for reversing receivers are described; one of these can be used for any synchro receiver, and the other, which is simpler, is limited in application to those receivers which have no internal or external jumpers between a rotor lead and a stator lead. Synchros with jumpers are hereafter called the four-wire type, and those with no jumpers are called the five-wire type. (All of the synchro receivers on the acquisition data consoles are the four-wire type. Terminals R2 and S2 are internally jumpered.)

(a). RECEIVER ZEROING PROCEDURE

This procedure is applicable to those synchro receivers which are not supplied from a synchro line amplifier. (A synchro line amplifier reverses the phase of the stator voltages; hence, synchro receivers connected to the output of an amplifier require reversing, not zeroing.)

1. Turn off reference voltage (115 VAC) to the synchro.
2. Disconnect stator leads (S1, S2, S3) from the synchro.
3. Connect a variac (General Radio Type W10MT) as shown in figure 5-5.



B: SYNCHRO RECEIVER.
VARIAC: GENERAL RADIO TYPE W10MT.

MAKE CONNECTIONS AND APPLY POWER AS SHOWN. SYNCHRO WILL TURN TO ELECTRICAL 180°.

TO ZERO: ROTATE CASE OR POINTER FOR SYNCHRO POINTER OR DIAL READING OF 180°.

TO REVERSE: ROTATE CASE OR POINTER FOR SYNCHRO POINTER OR DIAL READING OF 0°.

Figure 5-5. Method of Zeroing or Reversing Synchro Receiver

4. Turn on the 115 VAC reference voltage and adjust the variac for 78 VAC between synchro terminal S2 and terminals S1-S3. The synchro will turn to electrical 180 degrees.

5. Being careful not to short circuit the 115 VAC voltage, loosen the screws which hold the case of the synchro and turn the case so that the synchro pointer or dial is at 180 degrees.

6. Turn off the 115 VAC voltage and tighten the screws which hold the synchro case in place. The synchro is now zeroed.

Note

The synchro receivers on the acquisition data consoles are so constructed that they cannot be zeroed by turning the case; the pointer must be turned on the rotor shaft. Partially disassemble the synchro and remove the pointer from the rotor shaft in accordance with the instructions in paragraph 5-4.C.

(b). RECEIVER REVERSING PROCEDURES

The procedures which follow are applicable to synchro receivers which are connected to the output of a synchro line amplifier. Two procedures are described; the first is a very simple method of reversing (changing by 180 degrees) the reading of a receiver, but it cannot be used on synchros with four-wire connections (jumpers between rotor and stator leads) and it does not provide a check of the accuracy of the synchro indication. The second procedure can be used with either four-or five-wire connection synchro receivers and it provides check and adjustment of the receivers indication inasmuch as it is actually a procedure for "zeroing" at 180 degrees.

1. R1-R2 INTERCHANGE

CAUTION

Do not apply this procedure to any of the synchros on the acquisition data consoles or any others which have jumpers, internal or external, between a rotor winding and a stator winding. To do so may result in a direct short circuit of the 115 VAC reference voltage.

a. Turn off the 115 VAC reference voltage.

b. Disconnect the external leads from the synchro R1 and R2 terminals.

c. Connect to R1 the external lead which was formerly on R2.

d. Connect to R2 the external lead which was formerly on R1. The synchro reading is now reversed (different by 180 degrees) from what it was before R1 and R2 was interchanged.

2. "ZEROING" AT 180 DEGREES

a. Turn off reference voltage (115 VAC) to the synchro.

b. Disconnect stator leads (S1, S2, S3) from the synchro.

c. Connect a variac (General Radio Type W10MT) as shown in figure 5-5.

d. Turn on the 115 VAC reference voltage and adjust the variac for 78 VAC between synchro terminal S2 and the terminals S1-S3. The synchro will turn to electrical 180 degrees.

e. Being careful not to short circuit the 115 VAC voltage, loosen the screws which hold the case of the synchro and turn the case so that the synchro pointer or dial is at zero degrees.

f. Turn off the 115 VAC voltage and tighten the screws which hold the synchro case in place. The synchro is now reversed.

Note

For the synchros on the acquisition data consoles, see the note under paragraph 5-4.B.(3).(a). regarding zeroing by turning the pointer on the rotor shaft. For reversing, or "zeroing" at 180 degrees, follow the procedure in the referenced note, except turn the pointer to zero degrees.

(4). CONTROL TRANSFORMERS

Two procedures, one complete and one simplified, for zeroing control transformers are given below. The simplified procedure should be used only when the approximate electrical zero position of the control transformer is known. Normally, the approximate electrical zero position is known, and the simplified procedure can in most cases be used.

(a). CONTROL TRANSFORMER ZEROING PROCEDURE-COMPLETE

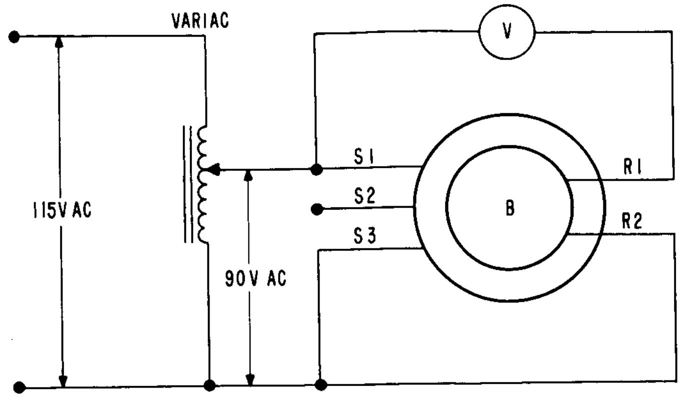
1. Set the device to which the control transformer is mechanically coupled to its zero-degree position.

2. Disconnect the rotor (R1, R2) and stator (S1, S2, S3) leads from the control transformer.

3. Connect a jumper between terminals R2 and S3 and connect a voltmeter (Hewlett-Packard 400D, 300-volt scale) between terminals R1 and S1. (See figure 5-6.)

4. Connect a variac (General Radio Type W10MT) between terminals S1 and S3 as shown on figure 5-6 and apply 90 VAC to these terminals.

a. If the meter reading is approximately 30 volts, the control transformer is near electrical zero. Proceed with the simplified zeroing procedure below.



B: CONTROL TRANSFORMER.
V: HEWLETT-PACKARD 400D AC VTVM.
VARIAC: GENERAL RADIO TYPE W10MT.

MAKE CONNECTIONS AND APPLY POWER AS SHOWN.

ROTATE CASE FOR MINIMUM READING ON METER.
(MINIMUM READING SHOULD BE ABOUT 30 VOLTS).

Figure 5-6. Method of Locating Approximate Position of Control Transformer Electrical Zero

b. If the meter reading is approximately 120 volts, the control transformer is near electrical 180 degrees. Turn off the power, loosen the screws which hold the case, and turn the case of the control transformer halfway around. Turn the power back on; the meter reading now should be approximately 30 volts. Proceed with the simplified zeroing procedure.

(b). CONTROL TRANSFORMER ZEROING PROCEDURE - SIMPLIFIED

1. Set the device to which the control transformer is mechanically coupled to its zero-degree position.

Note

See paragraph 5-4. B. (4). for restrictions on the use of this procedure.

2. Disconnect the rotor (R1, R2) and stator (S1, S2, S3) leads from the control transformer.

3. Connect a jumper between terminals S1 and S3 and connect a voltmeter (Hewlett-Packard 400D) between terminals R1 and R2. (See figure 5-7.) To protect the meter, set it initially on the 100-volt scale. As lower voltage readings are obtained during the following steps of the procedure, set the meter to successively lower scales.

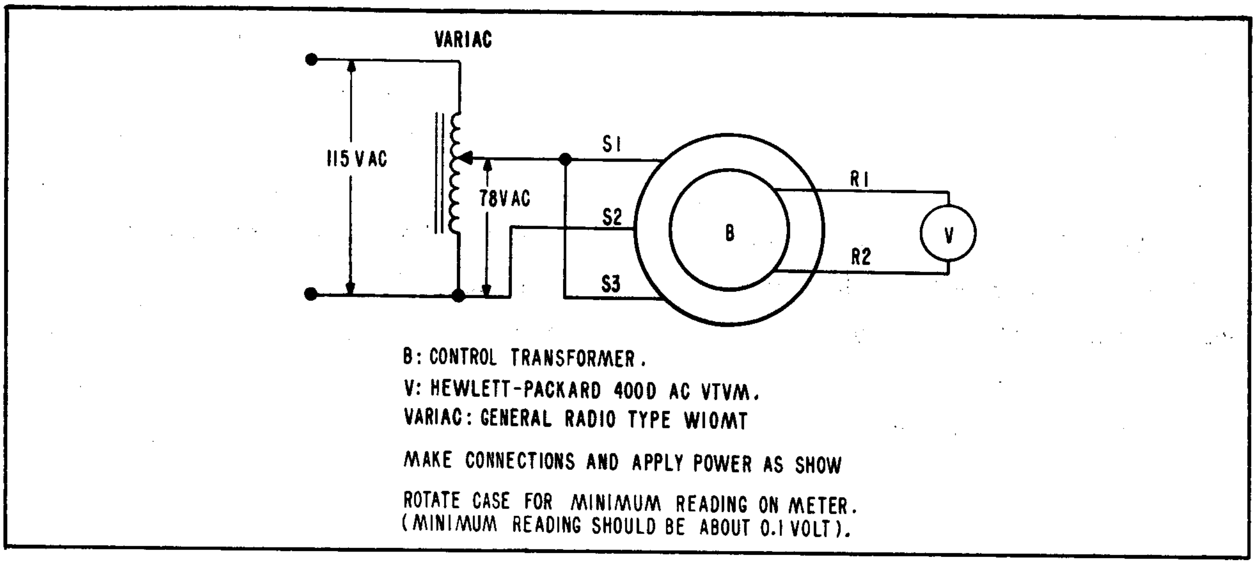


Figure 5-7. Method of Zeroing Control Transformer

4. Loosen the screws which hold the case of the control transformer so that the case is free to turn.

5. Connect a variac between terminals S1 and S2 as shown in figure 5-7 and apply 78 VAC to these terminals.

6. Turn the case of the control transformer in the direction which results in a decreasing meter reading. When a very low voltage reading is obtained, rotate the case of the control transformer back and forth to locate the position of null voltage on the meter. (Null voltage should be about 0.1 volt.) This position is the electrical zero of the control transformer.

7. With the control transformer set at electrical zero, tighten the screws which hold the case in place.

8. Turn off power and reconnect the control transformer for normal operation in its circuit.

(5). SYSTEM ALIGNMENT

In a system consisting of a synchro transmitter and a synchro receiver or control transformer, there are three places where misalignment errors commonly arise. These three are the transmitter, the receiver, and the circuits which connect the transmitter to the receiver. When the connecting circuits consist simply of cabling and/or fixed transformers, no adjustments can be made to them; errors can be corrected only at the transmitter or receiver. When the connecting circuits include a synchro line amplifier, error-correcting adjustments can be made at the transmitter, the receiver, and at the amplifier. In a simple system consisting of a single transmitter, synchro line amplifier, and receiver or control transformer (a control transformer for the purposes of this discussion being equivalent to a synchro receiver) a misalignment error can be corrected by adjusting any one of the three elements (transmitter, amplifier, or receiver). In such a simple system it is immaterial where the source of error actually is; a misadjustment of the transmitter can be compensated for by adjusting the receiver to introduce an equal and opposite error. The only criterion for proper operation is that when the device which drives the synchro transmitter is pointing at a given angle, the synchro receiver indicates that angle. However, the synchros in the acquisition system are not in a simple arrangement like that just described, and although shortcut methods can and should be used as the technician becomes familiar with the configuration and characteristics of the system, the general procedure given below should be followed in most cases:

(a). When an error is noted in the synchro system, determine if possible whether the error is due to a "trouble" or a misadjustment. The criteria for making this determination are discussed in paragraph 5-3.

(b). Isolate the source of the error as much as possible. That is, where there is more than one receiver connected to a transmitter, check all of the receivers to see whether the error shows up on all or on only one; switch between two transmitters which can be connected to a single receiver. (See figure 5-8. This illustration is a schematic of both the azimuth and elevation synchro systems, which are virtually identical.)

(c). Individually check the adjustment of each of the units (transmitter, receiver, control transformer, and synchro line amplifier) for possible source of the particular error. Careful adjustment of the individual units should correct the majority of system errors. Individual check and adjustment procedures for synchro transmitters and receivers and control transformers are given in paragraphs 5-4.B.(2).(3)., and (4)., and procedures for the synchro line amplifier are given in paragraph 5-4.G.

(d). When all of the individual units involved have been properly adjusted and the error still persists, its source must be in the connecting cabling. An error arising in the cabling, so long as it is constant at all angular positions of the synchros, can be compensated for by introducing equal and opposite errors into the synchro receivers. Thus, when individual adjustment of the units of the system does not correct the error, system alignment should be made as follows:

1. Do not change the synchro transmitters or synchro line amplifiers; i.e., leave these units as they were set in accordance with the individual adjustment procedure.

2. Set the device mechanically coupled to the transmitter to a known position (azimuth or elevation).

3. For synchro receivers, loosen the screws which hold the case and with the synchros energized (115 VAC applied) turn the case so that the receiver indication is the same as the position of the antenna.

Note

The case of the synchro receivers on the acquisition data consoles cannot be turned; the pointer must be turned on the rotor shaft. Refer to the note in paragraph 5-4.B.(3).(a).

4. Before adjusting a control transformer to compensate for errors introduced by interconnecting cabling, be sure that changing the setting of the control transformer will not introduce an error into the positioning system with which the control transformer is associated.

C. SYNCHRO REPAIR

(1). REPAIR PROCEDURES

(a). It is recommended that major repairs on synchro devices (transmitters, receivers and control transformers) not be attempted in the field. However, minor repairs such as replacing broken pointers or dial plates and repairing broken connections (where wiring is accessible) can be made. For information on replacement of defective parts or gaining access to internal wiring or synchros on the acquisition data consoles, refer to the disassembly and assembly procedures below. For information on other synchros in the acquisition system, refer to the applicable equipment manuals.

(b). When there is a question as to whether a synchro is defective and requires replacement, the winding resistances should be checked. For the synchros on the acquisition data consoles the d-c resistance of the stator windings (S1-S2, S2-S3, and S1-S3) should be about 96 ohms at room temperature, and the d-c resistance of the rotor winding (R1-R2) should be about 85 ohms at room temperature. For synchros in other equipment, comparable d-c resistance measurements should be obtained. (When a resistance measurement is doubtful, it is a good idea to compare the resistances of corresponding windings in two identical synchros, or two windings of the same synchro.)

(2). DISASSEMBLY

The disassembly procedure described in this paragraph applies to the synchro receivers on the acquisition data consoles. (See figure 5-9.)

(a). Dismount the synchro from the panel by removing the four mounting screws and nuts.

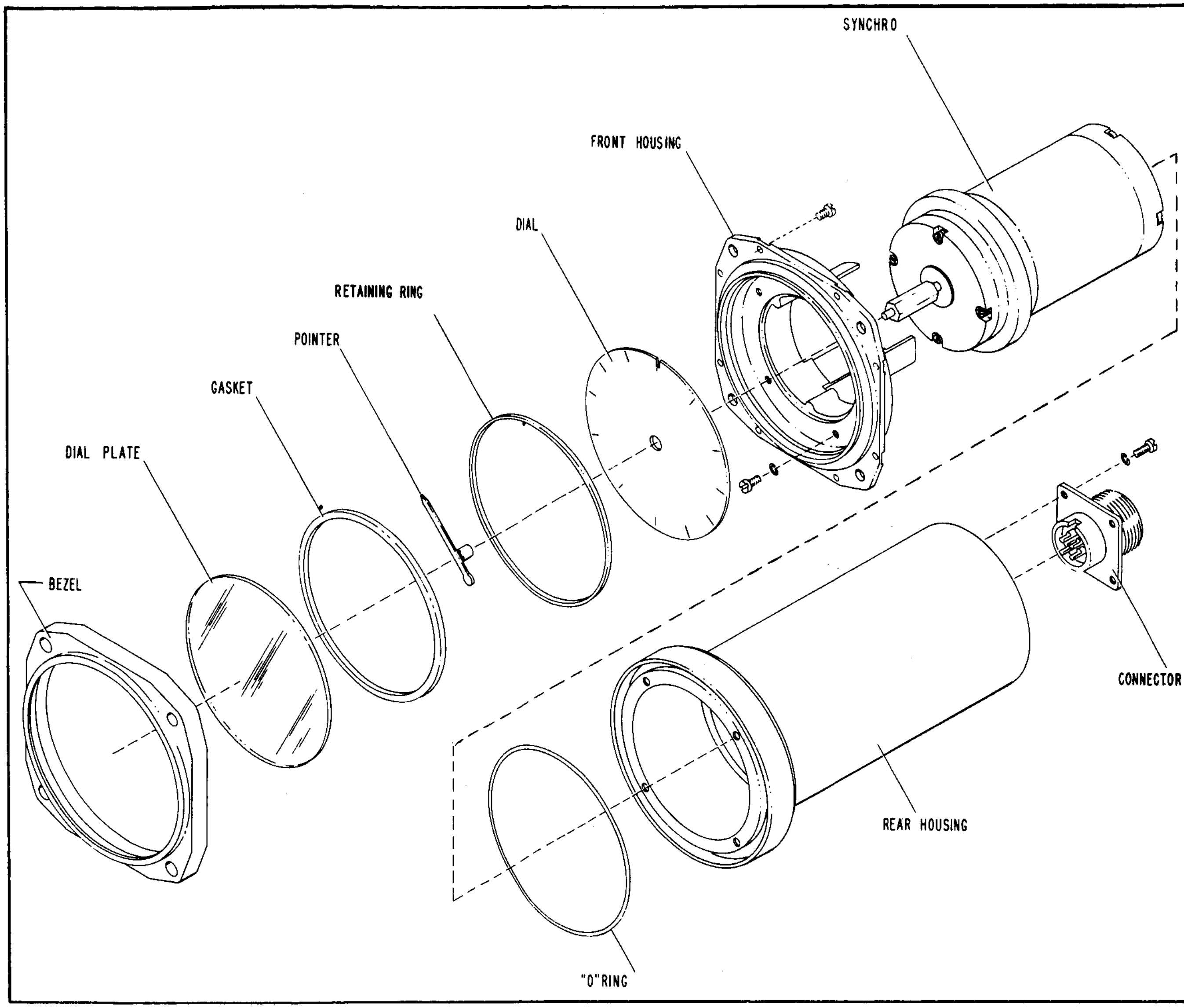


Figure 5-9. Acquisition Data Console Synchro Receiver, Exploded View

(b). Remove the eight screws which hold the bezel onto the front housing. Remove the bezel, dial plate and gasket and set them aside.

(c). Pull or pry the pointer off the end of the rotor shaft. As shipped from the factory the pointer is secured to the shaft with a drop of glue, and considerable force may be necessary to remove it. However, care should be exercised not to damage the fragile pointer during removal.

(d). Pull out the retaining ring and remove the dial.

(e). Remove the four screws which hold the front and rear housings together. Remove the front housing and "0" ring. With the front housing removed, only the wires from the connector to the synchro itself hold the synchro in the rear housing. Do not hold the rear housing in such a position that the connecting wires support the weight of the synchro.

(f). Remove the four screws which fasten the connector to the rear housing.

(g). Pull the connector as far away from the rear housing as the wiring permits and unsolder the wires from the connector pins. Drop the synchro itself out of the rear housing. This is as far as field disassembly should proceed.

(3). ASSEMBLY

Assembly of the synchro receivers on the acquisition data consoles is the reverse of the disassembly procedure, except that particular attention should be paid to the pointer. Be sure that the pointer is replaced at the proper angle on the rotor shaft (refer to paragraph 5-4.B.(3).), and if necessary crimp the pointer socket slightly to obtain a secure fit on the rotor shaft.

D. 28 VDC POWER SUPPLY

The acquisition data console 28 VDC power supply comprises two principal parts; one is the control circuits, and the other is the dual power supply. The control circuits consist of relays and diodes, on a relay chassis, and the switch assemblies (with indicators), on the acquisition data panel. The dual power supply consists of a front panel (with a switch, fuses, and a power-on indicating lamp) and power supplies number 1 and 2, each consisting of a power supply unit and a filter unit. This paragraph describes adjustment and repair procedures for the control circuits and for the dual power supply. Since it is unlikely that a single trouble in the console will affect both power supplies number 1 and number 2 and their associated control circuits, the repair procedures are based on the assumption that only one power supply and/or its associated control circuits is malfunctioning. If neither power supply is operative, check switch S6201 on the dual power supply and check the primary power, 115 VAC, to the console.

(1). CONTROL CIRCUITS

The following procedure is applicable specifically for checking and isolating trouble in the control circuits associated with power supply number 1. With appropriate substitutions in the reference designations of components, terminals, etc., the same procedure is applicable to the control circuits associated with power supply number 2.

(a). With switch S6201 on the dual power supply in the off position, connect a temporary jumper around blocking diode CR6001. The purpose of the jumper is to connect 28 VDC from power supply number 2 of the control circuits of power supply number 1.

(b). Remove plug P6201 from jack J6201 on the dual power supply.

(c). Turn on switch S6201 on the dual power supply and depress switch S6004 (receiver site) or S6007 (radar site) on the acquisition data panel. Power supply number 2 is energized and 28 VDC is applied to the control circuits of power supply number 1. If the power supply number 1 control circuits are functioning properly, the green indicator lamps in switch S6003 or S6006 on the acquisition data panel will be lit, and the switch when depressed will stay depressed, connecting 115 VAC to pins A and B of plug P6201 (measure with a voltmeter). Failure to perform as described indicates that the trouble is in the control circuits; proceed as follows to isolate the trouble.

(d). With a voltmeter measure the voltage across zener diode CR6003. It should be 18 ±1 VDC; if it is not, the diode is defective.

(e). Check the coil and contacts of relay K6001. The coil should have a d-c resistance of 1000 ohms. The contacts can conveniently be checked by measuring the voltage drop across each pair that should be closed; there should of course be no voltage across closed contacts.

(f). Check the coil, contacts, and indicator lamps in switch S6003 or S6006. The coil should have a d-c resistance of 480 ohms. Check the contacts for voltage drop across each pair that should be closed.

(2). DUAL POWER SUPPLY

(a). ADJUSTMENT

The individual power supplies in the dual power supply should be adjusted so that at the maximum normal load imposed by the console and with the prevailing a-c line voltage input to the console, the output of each power supply onto the console 28 VDC bus is as close as possible to 25 VDC. With a given a-c line voltage, a d-c output voltage within the range of 24 to 26 VDC normally should be obtainable. If only the extremes of this range can be obtained, the output voltage should be set at the higher end of the range. Also, the power supplies should be adjusted so that with extremes of line voltage fluctuation and with d-c load variations from minimum to maximum, the d-c voltage output of the dual power supply is in no case greater than 30 VDC or less than 22.5 VDC. Voltages greater than 30 VDC are likely to overheat and thus damage the color filters in the console indicators, and any voltage less than 22.5 VDC may not be sufficient to operate the power supply control circuits. The curves of figures 5-10 and 5-11 are provided for reference in case it is necessary to adjust the power supplies with an a-c line voltage other than the prevailing one or with loads which differ appreciably from the normal maximum. The curves of figure 5-10 include the effects of the power supply control circuits and therefore apply when the dual power supply is in the console and voltages are measured on the console 28 VDC bus. The curves of figure 5-11 apply when the control circuits are disconnected and voltages are measured right at the output of a filter unit (terminal board TB6203 or TB6204, terminals 3 and 2) as when the dual power supply is on the bench. For an a-c line voltage near 115 VAC, transformer secondary connections to terminal board terminals 2 and 4 should provide the proper d-c output voltage. (The maximum normal load is approximately one ampere.) For other a-c line voltages, the curves of figures 5-10 and 5-11 show the transformer secondary connections which should produce the correct output voltage. Proceed as follows to check and adjust the power supply output voltages when the dual

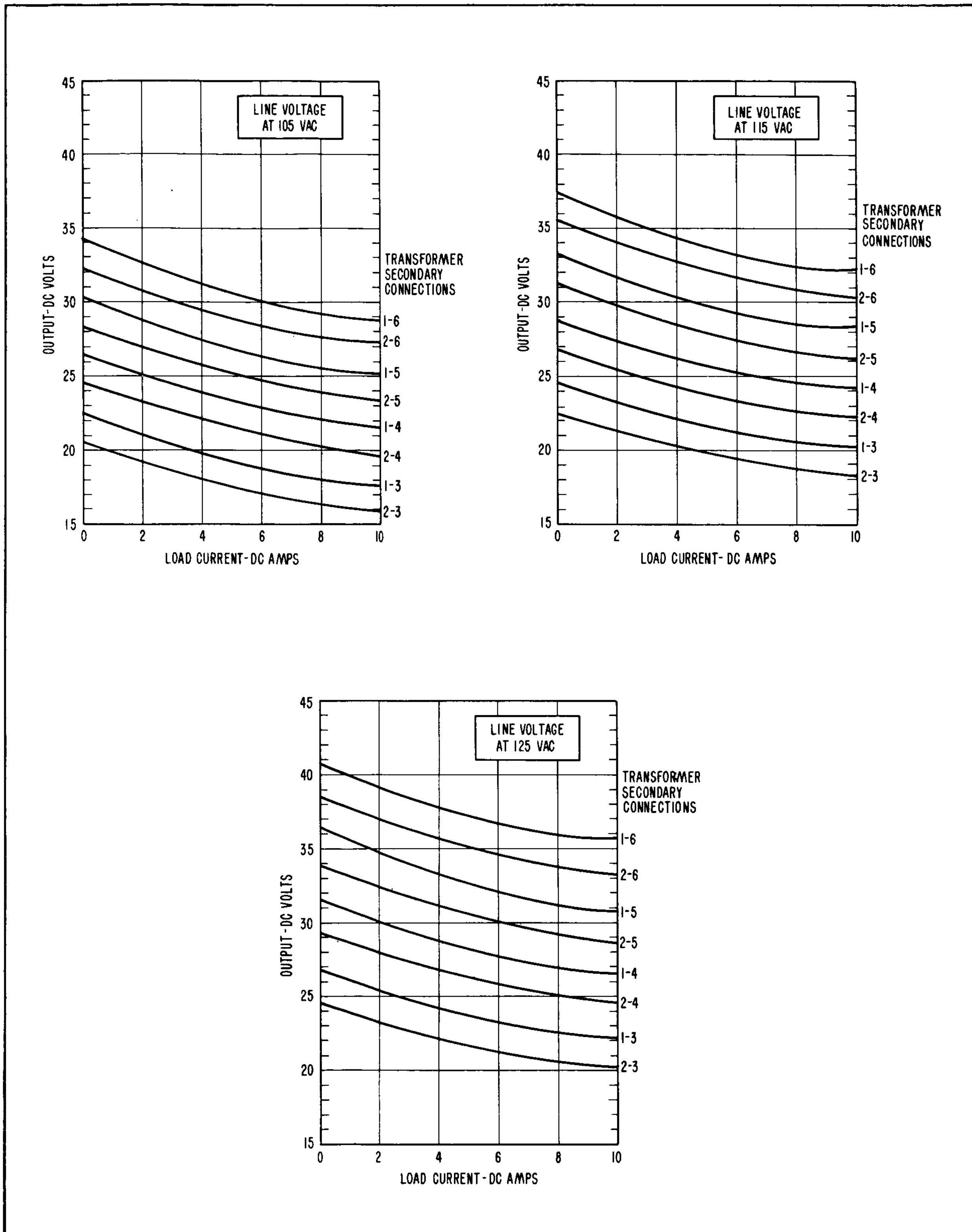


Figure 5-10. Power Supply and Control Circuit Output Voltage versus Load Current Characteristics

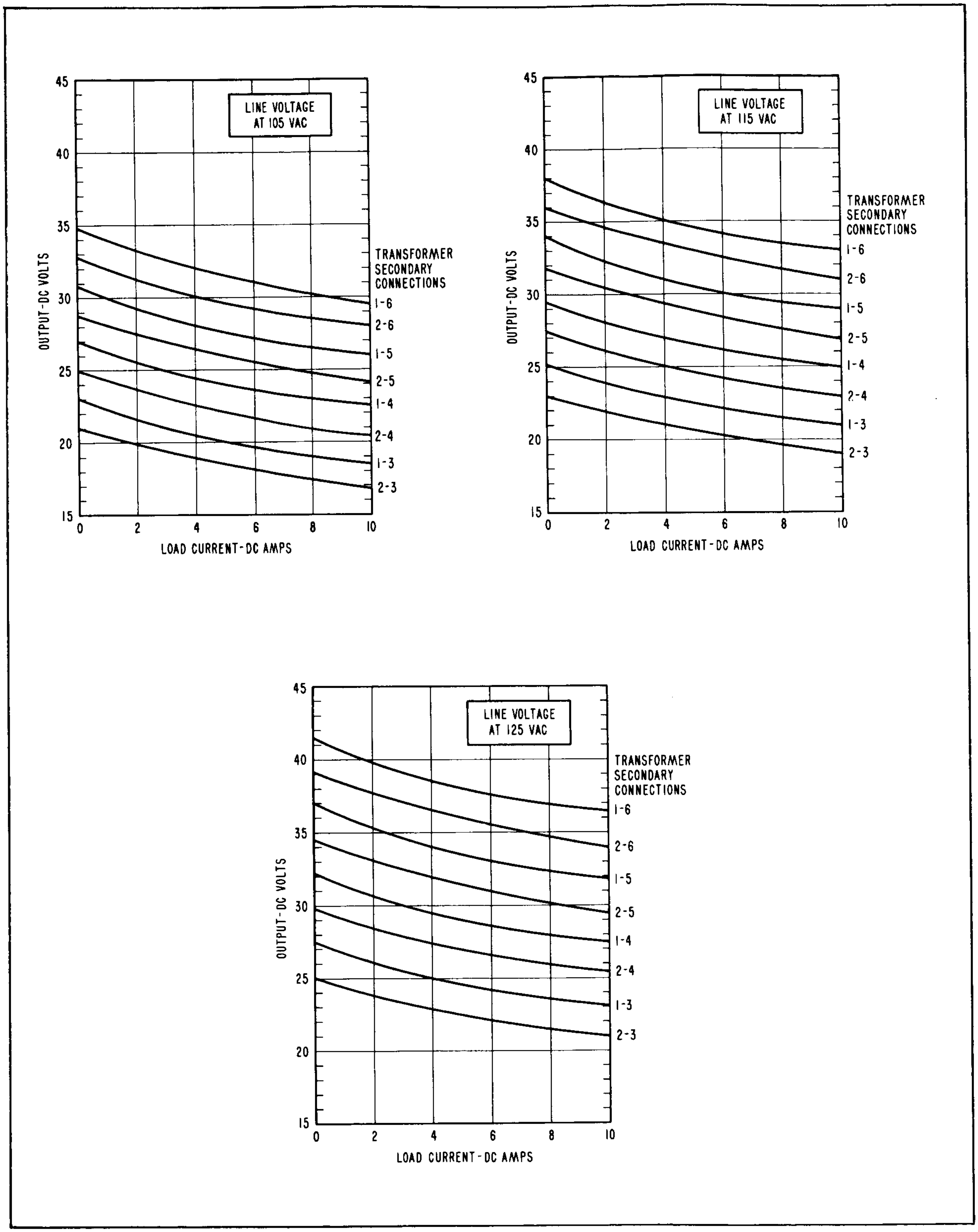


Figure 5-11. Power Supply Output Voltage versus Load Current Characteristics with Control Circuit Disconnected

power supply is connected to the console for normal operation. The procedure for checking and adjusting when the dual power supply is on the bench is essentially the same as the following, but the details of the on-the-bench procedure will depend on the particular test setup used:

1. Energize power supply number 1 by turning on switch S6201 on the dual power supply and depressing "28V SUPPLY" switch S6006 (radar site console) or S6003 (receiver site console).

2. Apply maximum normal load to the power supply by energizing as many switches, indicators and relays as can be energized at one time.

3. Measure the voltage output of power supply number 1 between terminals 3 and 4 of terminal board TB6001 or any other convenient place on the console 28 VDC bus. (See figure 7-1 or 7-3.)

4. The output voltage of the power supply should be as described above (24 to 26 volts with the prevailing a-c line voltage supplied to the console). If it is not, adjust the voltage by changing on terminal board TB6201 the connections to the secondary taps of transformer T6201. By changing these connections, the d-c output voltage of the power supply can be adjusted over a range of about 14 volts in steps of approximately two volts. Moving one connecting wire between TB6201 terminals 3 and 4, 4 and 5, or 5 and 6 increases or decreases the d-c output by about four volts; and moving the other connecting wire between TB6201 terminals 1 and 2 increases or decreases the output voltage by about two volts. (See figure 5-12.)

5. Turn off power supply number 1 and repeat steps one through four with appropriate changes in reference designations for power supply number 2.

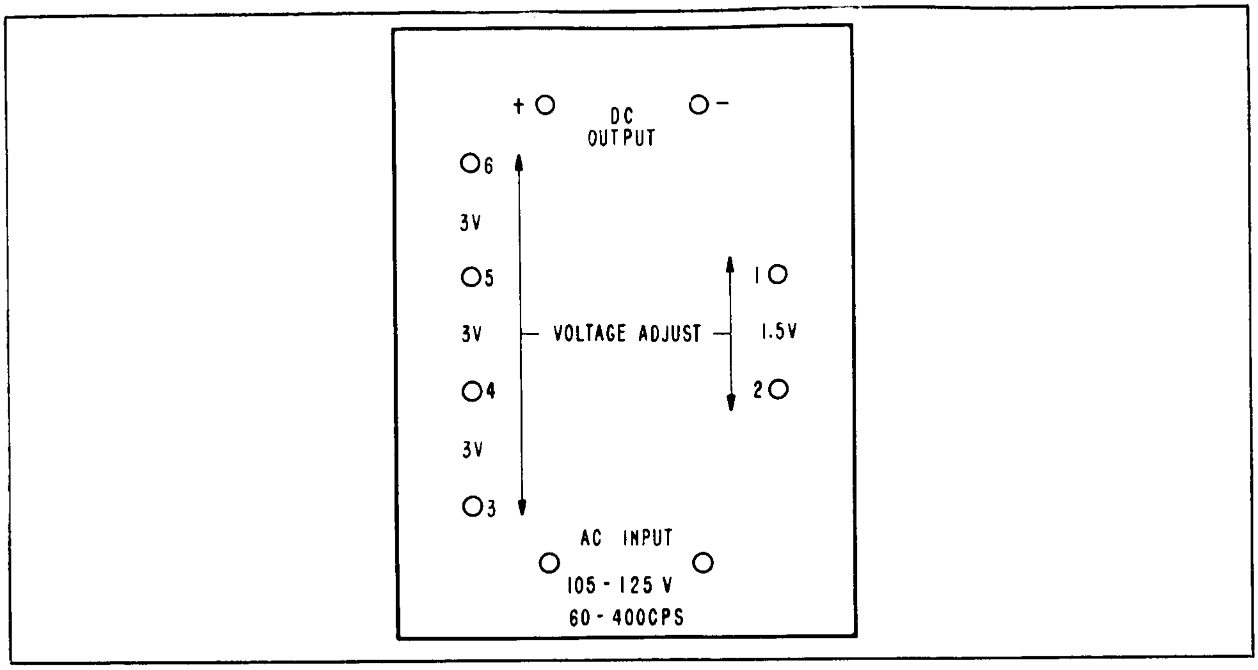


Figure 5-12. Power Supply Unit Terminal Board

(b). REPAIR

Correction of a malfunction in the dual power supply can be affected by conventional trouble shooting and repair procedures. Check a-c and d-c voltages and check continuity of power transformer T6201 or T6202 and filter choke L6201 or L6202. See the dual power supply schematic and physical wiring diagrams, figures 7-5 and 7-6. For the location of parts on the power supply units and filter units, see figure 5-13. Normal a-c voltages for the power transformers are shown in table 5-II. Bear in mind that two switches are in series with the primary 115 VAC power to each power supply in the dual power supply; for power supply number 1 these switches are S6201 on the dual power supply and S6003 (receiver site) or S6006 (radar site) on the acquisition data panel; for power supply number 2 the switches are S6201 on the dual power supply and S6004 (receiver site) or S6007 (radar site) on the acquisition data panel. Bear in mind also that in addition to the fuses, F6201-F6204, on the front panel of the dual power supply, there is another fuse (F6205, F6206) on each of the power supply units (PS6201 and PS6202).

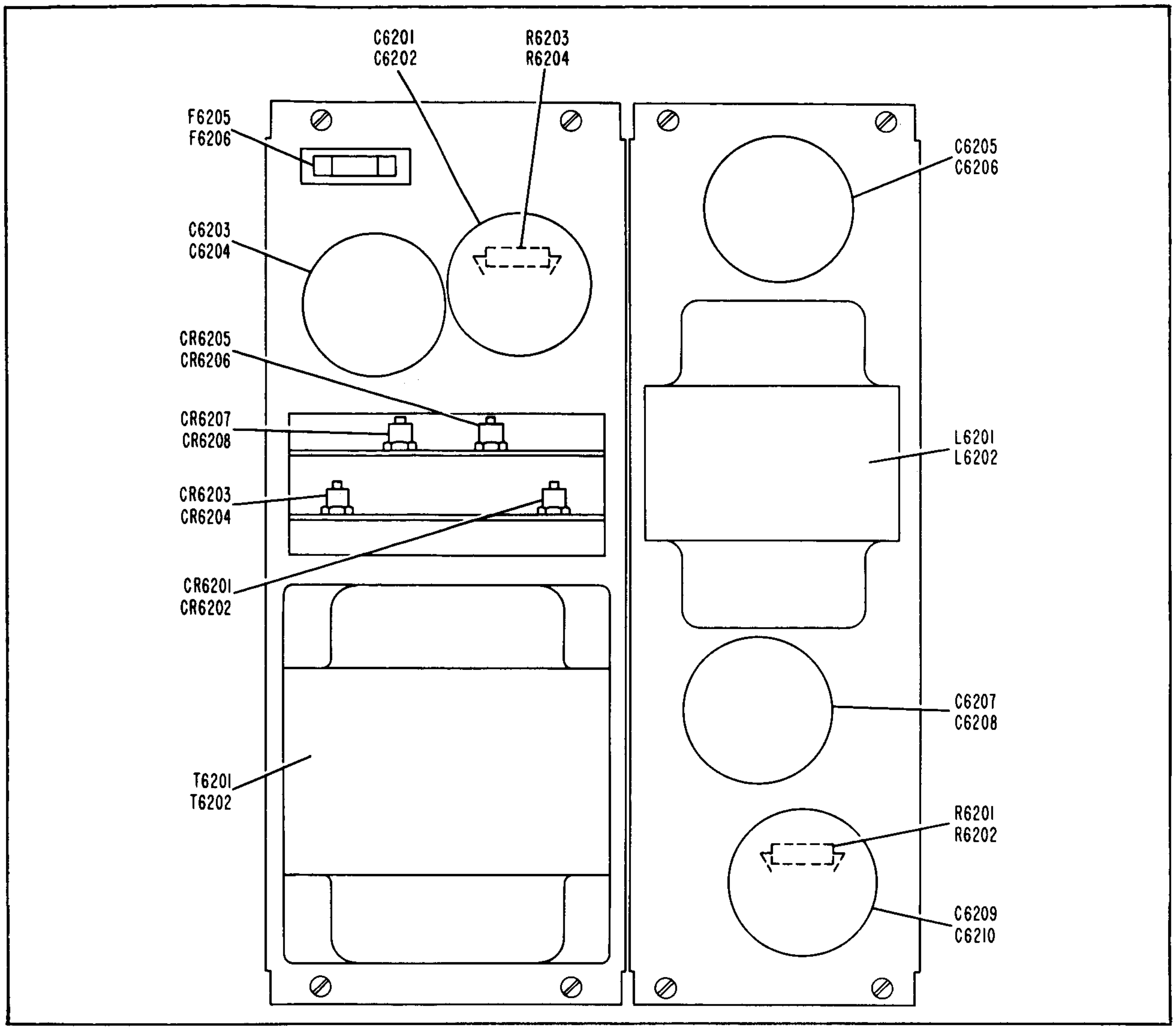


Figure 5-13. Power Supply Unit and Filter Unit, Parts Location

TABLE 5-II. NORMAL POWER TRANSFORMER VOLTAGES (T6201, T6202)

Terminals (TB6201 or TB6202)	Approximate RMS Voltage
1-6	28
2-3	18
1-2	1.5
3-4	3
4-5	3
5-6	3
7-8	115

E. RELAYS

(1). All of the relays used on the acquisition data consoles are hermetically sealed, and no maintenance or repair is possible. When one of them becomes defective, replace it. To ascertain that a console relay is defective, check the following:

(a). Coil resistance: D-c coil resistances should be as shown in table 5-III.

(b). Contacts: With all power off, check continuity between normally closed contacts. With the suspected relay energized and voltage applied across the contacts, check for voltage drop across normally open contacts. There should of course be none.

(2). For detailed information on relays in the acquisition system outside the acquisition data consoles, see the applicable equipment manuals, listed in table 1-II.

TABLE 5-III. ACQUISITION DATA CONTROL RELAY COIL RESISTANCES

Radar Site Console		Receiver Site Console	
Reference Designation	Approximate Resistance (Ohms)	Reference Designation	Approximate Resistance (Ohms)
K6001	1000	K6001	1000
K6002	1000	K6002	1000
K6003	1000	K6003	200
K6004	1000	K6004	200
K6005	200	K6005	1000
K6006	200	K6006	1000
K6010 (note 1)	10.5K	K6007	1000
K6011 (note 1)	10.5K	K6008	1000

Note 1: Diodes are in series with the coils of relays K6010 and K6011. Hence, polarity must be observed when measuring the resistance of these coils with an ohmmeter. (See figure 7-1.) The resistance given in the table is that of the coil plus diode forward resistance.

F. SWITCH AND INDICATOR ASSEMBLIES

For a description of acquisition data console switch and indicator assemblies and how they work, refer to paragraph 4-2.B.(3). and figure 4-5.

(1). INDICATORS AND OPERATOR-INDICATOR UNITS

Maintenance of indicators and the operator-indicator unit portion of switch assemblies consists simply of replacing loose or defective lamps and color filters. Replacement of these items is most easily accomplished with the use of the special lamp-filter tool, shown in figure 5-19 (Microswitch part number 15PA19).

(2). COILS

The coil portion of switch assemblies can best be checked by observing the action of the plunger. When the plunger is depressed and the coil energized, the plunger should remain securely in the depressed, or actuated, position. Also check the d-c resistance of the coil. It should be about 480 ohms.

(3). SWITCHES

The operation of the switch portion of switch assemblies can be checked by seeing whether all of its contacts make and break properly as the coil plunger is depressed and released. Faulty or intermittently faulty operation of a switch section can often be corrected by adjusting the amount of bend in the small arm which actuates the individual switch section plunger (as distinguished from the main, or coil plunger). When the operation of a switch section is faulty and cannot be corrected, the entire switch portion of the switch assembly must be replaced.

G. SYNCHRO LINE AMPLIFIER

This paragraph covers two procedures for adjusting the synchro line amplifiers; one is an on-the-bench procedure whereby the amplifier can be adjusted independently of any synchros, and the other is an in-system procedure, which in some cases will be more convenient to perform or may be necessary for touching up the adjustments. However, of the two, the on-the-bench procedure usually will produce the more satisfactory results; it is therefore the one which normally should be used. Both procedures described apply to both the azimuth and elevation channels of the synchro line amplifier (the two channels are identical); thus, for complete adjustment of the amplifier, the procedure used will have to be followed twice, once for the azimuth channel and once for the elevation channel. For synchro line amplifier trouble shooting and repair procedures, see the applicable equipment manual, listed in table 1-II.

(1). BENCH ADJUSTMENT

(a). Connect a variac (General Radio type W10MT) to the synchro line amplifier channel which is to be adjusted. Connect the variac so that 78 VAC can be applied to the amplifier between pins C and A-B of jack P1. (See figure 5-14.)

WARNING

Be sure to connect the neutral (synchro R2 winding) side of the 115 VAC power to pin C of jack P1 on the line amplifier. Connecting the "hot" (synchro R1 winding) side of the 115 VAC power to pin C of P1 would put 115 VAC directly on the chassis of the synchro line amplifier.

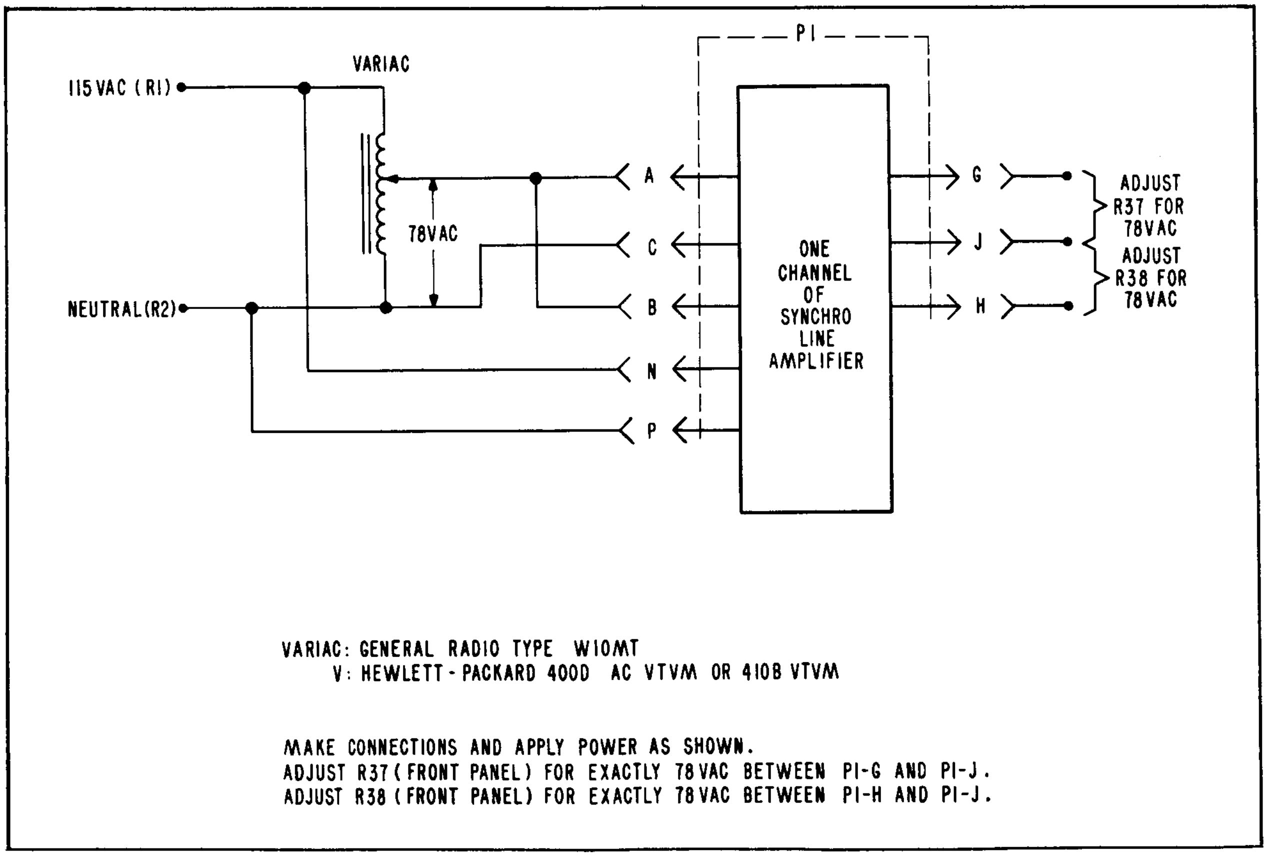


Figure 5-14. Synchro Line Amplifier, Bench Adjustment Setup

(b). Before the synchro line amplifier is turned on (by means of switch S1 on the front panel), adjust the output of the variac for 78 VAC.

(c). Turn on switch S1 of the amplifier channel to be adjusted and allow about 10 minutes warm-up time before proceeding with the adjustment procedure.

(d). With a voltmeter (Hewlett-Packard 400 D AC VTVM or 410B VTVM) measure the output voltage of the line amplifier between pins G and J of jack P1.

(e). Adjust calibration potentiometer R37 (on the front panel of the line amplifier, figure 3-4) for exactly 78 VAC on the voltmeter.

(f). Reconnect the voltmeter between pins H and J of P1 and adjust calibration potentiometer R38 (on the front panel of the line amplifier, figure 3-4) for exactly 78 VAC between these pins.

(g). In order to balance the amplifier output precisely, reconnect the voltmeter between pins G and H of P1 and adjust either calibration potentiometer (R37 and R38) for a null voltage reading. The amplifier channel is now properly adjusted.

CAUTION

Although there is little potential difference between pins G and H of P1, both of these pins are at 78 VAC with respect to chassis ground. Use care when connecting the meter leads.

(2). IN-SYSTEM ADJUSTMENT

In-system adjustment of the synchro line amplifier consists of connecting a synchro transmitter to the input of the amplifier and adjusting the amplifier so that its output is the same as the output of the synchro transmitter. Any synchro transmitter which is normally connected to the synchro line amplifier can be used as the reference for adjustment, and in some cases the best system performance may be obtained if the adjustment is made with a normal load on the amplifier; i.e., with normal, operating connections made to the amplifier output. If difficulty is encountered in obtaining proper system alignment, the amplifier should be adjusted with normal load on the output and with no load on the output to see which method gives the better results.

(a). Apply power by means of switch S1 to the synchro line amplifier channel to be adjusted and energize the synchros connected to the line amplifier. Allow the amplifier to warm up for about 10 minutes.

(b). Set the synchro transmitter which is connected to the input of the amplifier to exactly zero degrees.

Note

When using this procedure, the accuracy of the synchro line amplifier adjustment is dependent on the accuracy of the synchro transmitter used. Therefore, be sure that the synchro transmitter has been properly adjusted. (Refer to paragraph 5-4.B.)

(c). With a voltmeter (Hewlett-Packard 400 D AC VTVM or 410 B VTVM) measure the output voltage of the line amplifier between pins G and J of jack P1.

(d). Adjust calibration potentiometer R37 (on the front panel of the line amplifier) for exactly 78 VAC on the voltmeter.

(e). Reconnect the voltmeter between pins H and J of P1 and adjust calibration potentiometer R38 (on the front panel of the line amplifier) for exactly 78 VAC between these pins.

(f). Reconnect the voltmeter between pins G and H of P1 and adjust either calibration potentiometer (R37 or R38) for a null voltage reading. The amplifier channel is now properly adjusted.

CAUTION

Pins G and H of P1 are at 78 VAC with respect to chassis ground. Use care when connecting the meter leads.

H. AUDIO AMPLIFIER

(1). ADJUSTMENT

No adjustment of the audio amplifier is required.

(2). REPAIR

(a). Since the circuitry of the audio amplifier is conventional and simple, ordinary trouble shooting techniques may be employed to correct malfunctions in it. When the amplifier is working properly, a signal of approximately four millivolts, 1000-cycles applied at terminal TB1-2 is sufficient to drive output stage V3 into saturation. The test setup needed to obtain a four-millivolt signal with a Hewlett-Packard 200 CD wide range oscillator (audio signal generator) is shown in figure 5-15. A four-millivolt signal into the amplifier when it is operating normally produces an uncomfortably loud output from the speaker; therefore, it may be desirable to switch the speaker off while making checks. Switching the speaker off connects a five-ohm resistive load (R8 and R12) in place of the speaker and therefore does not alter the operating characteristics of the amplifier.

(b). Figures 5-16 and 5-17 are terminal voltage and terminal resistance diagrams of the audio amplifier when it is in good working order. The values given on figure 5-16 with a four-millivolt signal applied are those obtained with the test setup shown in figure 5-15. The information on these diagrams should enable the technician quickly and easily to isolate and correct a malfunction in the amplifier.

(c). For the location of parts on the audio amplifier, see figure 5-18.

I. SIGNAL STRENGTH METER CALIBRATION

To calibrate each of the signal strength meters on the receiver site acquisition data console signal strength meter panel, proceed as follows:

(1). Connect an r-f signal generator to the telemetry receiver with which the meter is to be calibrated is associated. (Refer to the Telemetering System Manual, MS-106 for further information on the signal generator and telemetry receiver.)

(2). With the telemetry receiver in operating condition and the signal generator frequency set at the operating frequency of the receiver, adjust the signal generator output level to 100 microvolts.

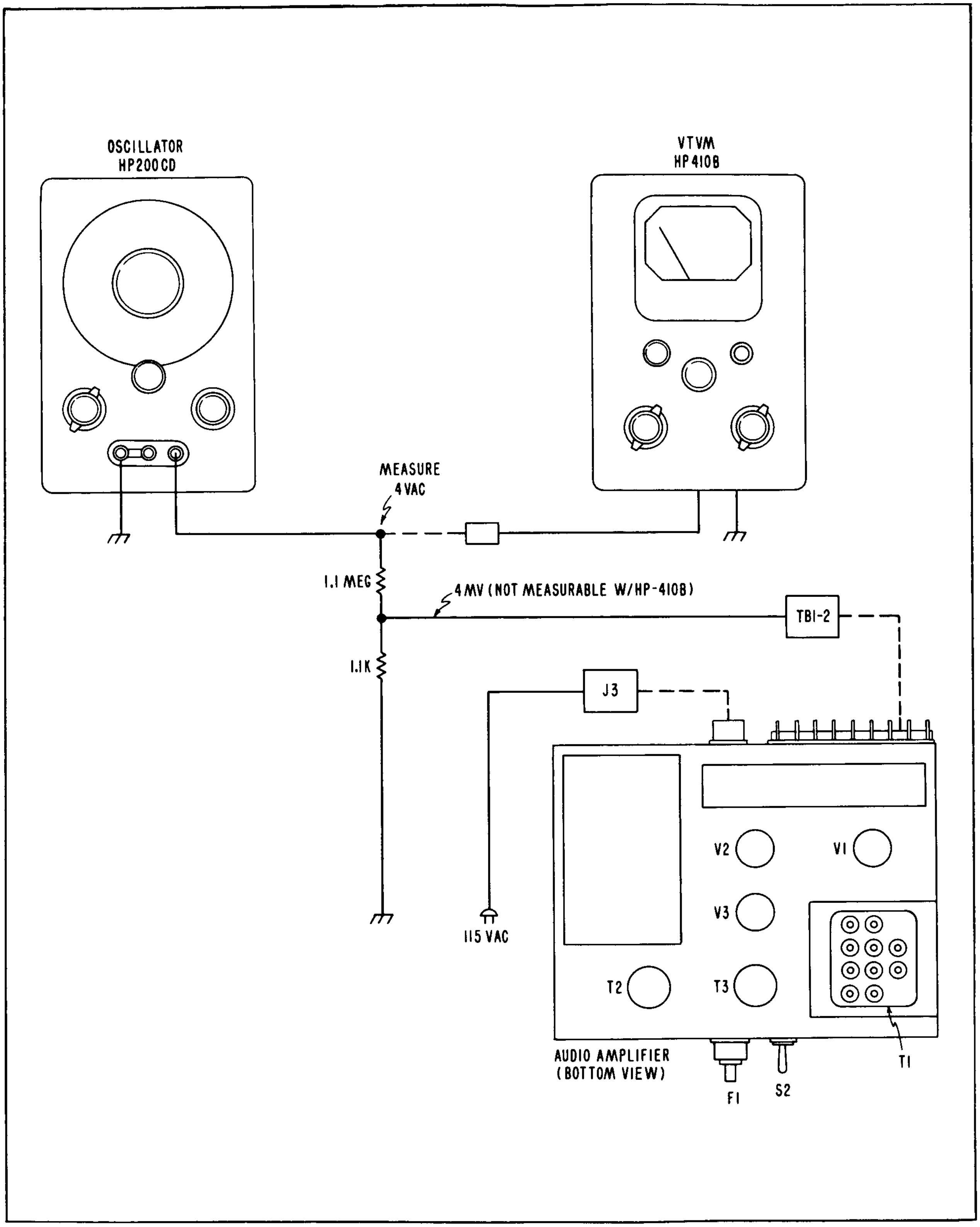
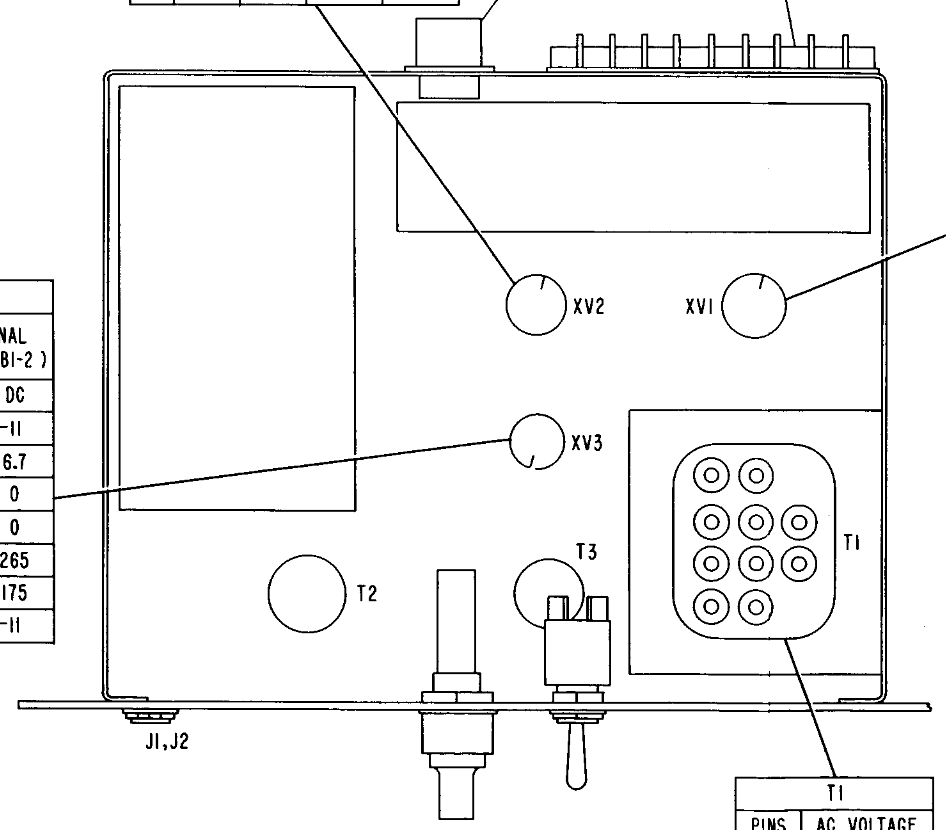


Figure 5-15. Audio Amplifier, Test Setup

PIN	V2 (5751) NO SIGNAL * AC	DC	4MV SIGNAL (APPLIED TO TB1-2) AC	DC
1	0	52	.7	48
2	0	0	-	0
3	0	.9	-	.9
4	0	0	0	0
5	0	0	0	0
6	0	100	13.5	110
7	0	0	.7	-.6
8	0	.9	1.3	.75
9	6.3	0	6.3	0

PIN	V3 (6AQ5) NO SIGNAL * AC	DC	4MV SIGNAL (APPLIED TO TB1-2) AC	DC
1	.3	0	13.5	−11
2	0	7.8	0	6.7
3	6.3	0	6.3	0
4	0	0	0	0
5	6.6	255	140	265
6	0	185	0	175
7	.3	0	13.5	−11

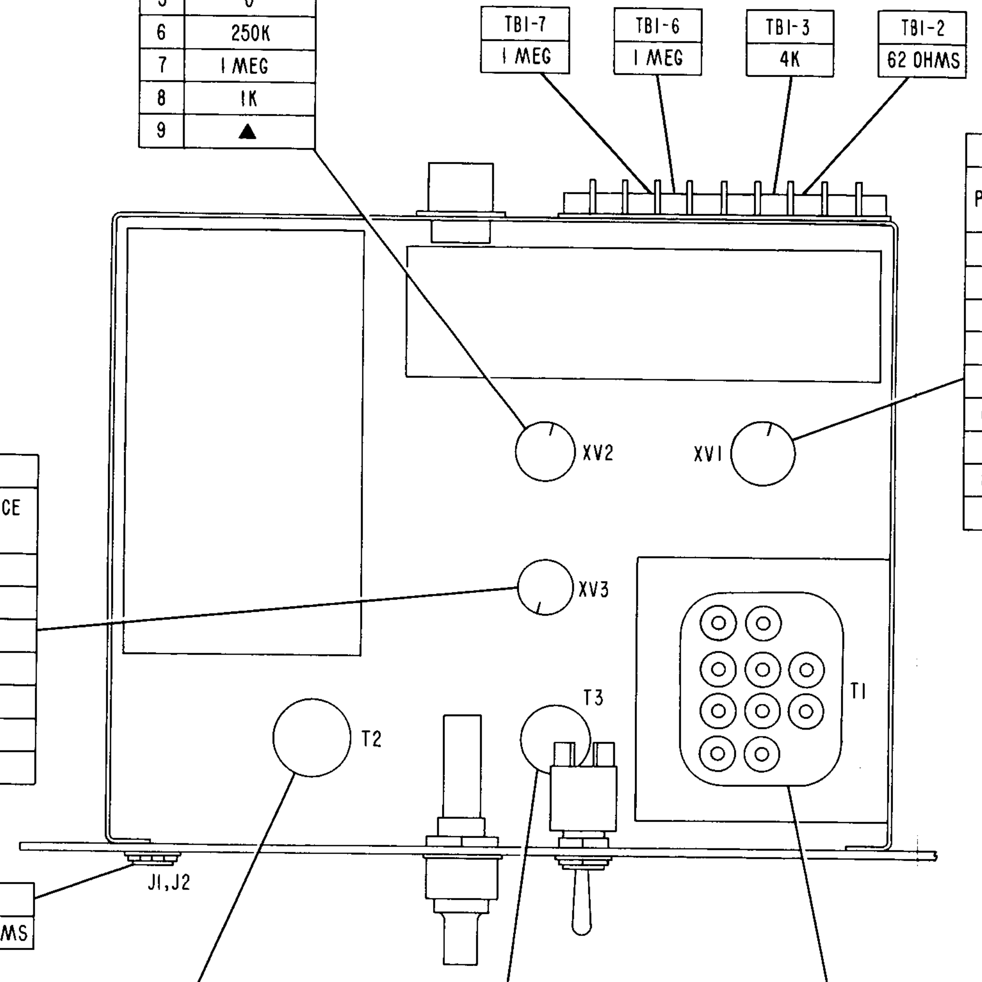
PIN	V1 (6203) NO SIGNAL * AC	DC	4MV SIGNAL (APPLIED TO TB1-2) AC	DC
1	225	-5	225	-4.6
2	-	-	-	-
3	-	-	-	-
4	-	-	-	-
5	-	-	-	-
6	-	-	-	-
7	5.5	280	5.5	290
8	-	-	-	-
9	225	-5	225	-4.6



T1 PINS	AC VOLTAGE
1-2	115VAC
3-5	450VAC CT
6-8	6.3VAC CT
9-10	5.0VAC

NOTES:
1. VOLTAGES GIVEN ARE TYPICAL VALUES, MEASURED WITH A VTVM.
2. MEASUREMENTS ARE MADE WITH RESPECT TO CHASSIS GROUND.
3. VOLTAGES ARE POSITIVE EXCEPT WHERE INDICATED.
4. LINE INSIDE TUBE SOCKET DENOTES "KEYWAY".
5. IF DESIRED, SPEAKER SWITCH S1 MAY BE TURNED TO "OFF".
6. CONDITIONS:
   A. VOLUME CONTROL ON ACQUISITION DATA CONSOLE PANEL FULLY CLOCKWISE.
   B. LINE POWER CONNECTED TO J3 (115VAC).
   C. SWITCH S2 IN THE "ON" POSITION.
   D. * INDICATES TB1-2 GROUNDED TO CHASSIS FOR VOLTAGE CHECK WITH NO SIGNAL APPLIED.
   E. 4MV, 1000CPS SIGNAL APPLIED TO TB1-2 FOR VOLTAGE CHECK WITH SIGNAL APPLIED.

Figure 5-16. Audio Amplifier, Terminal Voltage Diagram



V2 (5751)	
PIN	RESISTANCE OHMS
1	620K
2	4K
3	3.3K
4	0
5	0
6	250K
7	1 MEG
8	1K
9	▲

V1 (6203)	
PIN	RESISTANCE OHMS
1	250*
2	∞
3	∞
4	∞
5	∞
6	∞
7	172K
8	∞
9	250*

V3 (6AQ5)	
PIN	RESISTANCE OHMS
1	150K
2	220
3	▲
4	0
5	172K
6	150K
7	150K

J1	J2
32 OHMS	32 OHMS

T2*	
PINS	DC RESISTANCE
1-2	10
2-3	20
3-4	0
1-3	30
4-5	20
5-6	10
1-6	60
6-7	0
7-8	4K

T3*	
PINS	DC RESISTANCE
1-2	230
2-3	—
3-4	▲
4-5	▲
5-6	▲
6-7	20
7-8	12
3-8	33
4-8	32

T1*	
PINS	DC RESISTANCE
1-2	12
2-3	∞
3-4	250
4-5	250
3-5	500
5-6	∞
6-7	▲
7-8	▲
8-9	∞
9-10	▲

NOTES:
1. RESISTANCES GIVEN ARE TYPICAL VALUES.
2. MEASUREMENTS ARE TAKEN TO CHASSIS GROUND.
3. RESISTANCE READINGS ARE IN OHMS, K=1000, MEG=1,000,000, ∞=INFINITY.
4. LINE INSIDE TUBE SOCKET DENOTES "KEYWAY".
5. TRANSFORMER MEASUREMENTS ARE PIN TO PIN DC RESISTANCES.
6. ▲ INDICATES VALUES TO SMALL TO READ WITH METER.
7. CONDITIONS:
   A. VOLUME CONTROL ON ACQUISITION DATA CONSOLE PANEL FULLY CLOCKWISE.
   B. NO EXTERNAL LEADS CONNECTED.
8. * INDICATES VALUES TAKEN WITH UNIT AT ROOM TEMPERATURE.

Figure 5-17. Audio Amplifier, Terminal Resistance Diagram

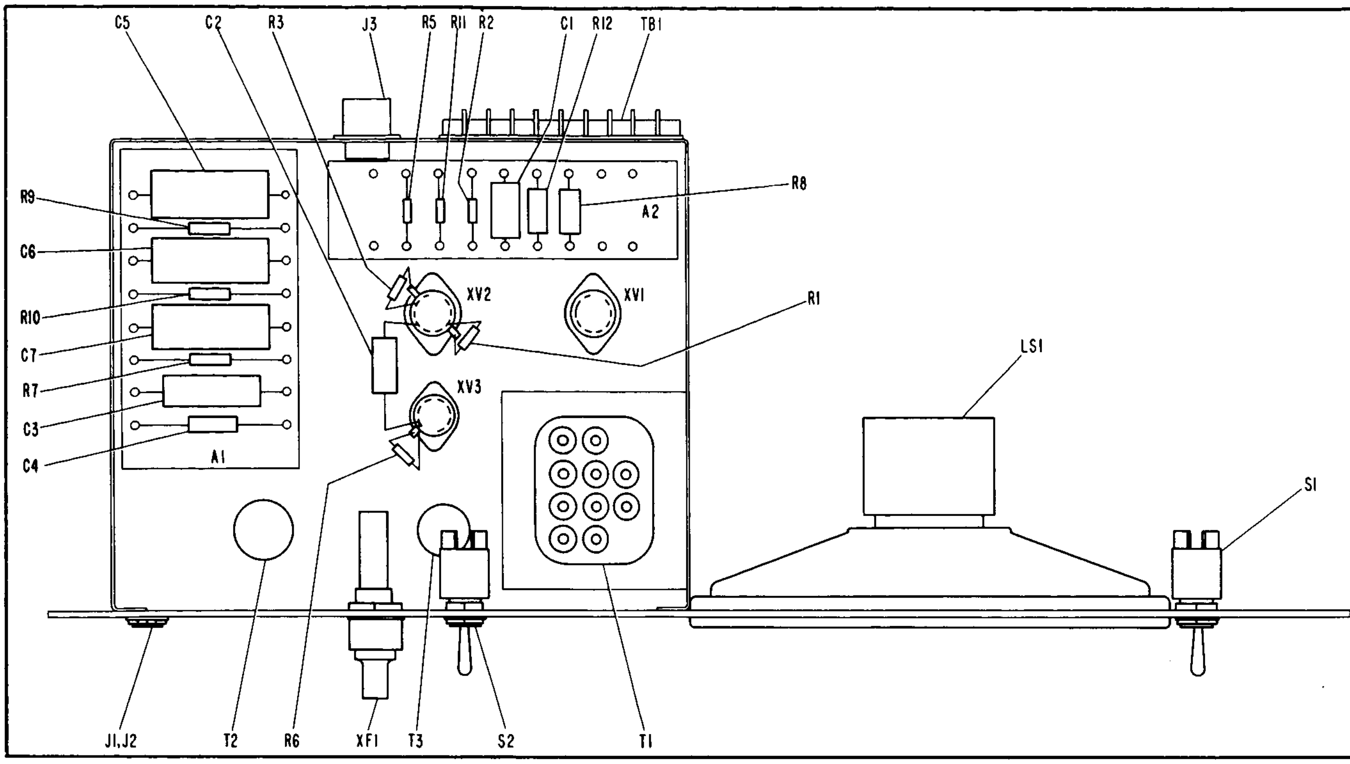


Figure 5-18. Audio Amplifier, Parts Location

(3). Adjust SIGNAL STRENGTH METER CALIBRATION CONTROL R6001, R6002, R6003 or R6004 (figure 3-5) until the meter with which it is associated indicates 100 microvolts.

5-5. LUBRICATION

Table 5-IV is a lubrication schedule for all of the equipment in the acquisition system.

5-6. SPECIAL TOOLS

The only special tool required for maintenance of the acquisition system is the lamp-filter tool (Microswitch part number 15PA19, Bendix Radio Part number A683836-1). This tool, shown in figure 5-19, is used for removal and replacement of the lamps and color filters in the indicators and switch assemblies on the acquisition data consoles.

5-7. TEST EQUIPMENT

Each piece of test equipment required for maintenance of the acquisition system is listed in table 5-V along with a brief description of its application.

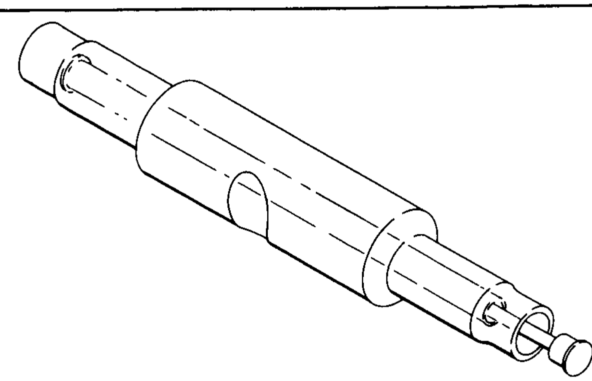


Figure 5-19. Lamp-Filter Tool

TABLE 5-IV. LUBRICATION SCHEDULE

Lubrication Point	Procedure	Lubricant	Frequency
ACQUISITION DATA CONSOLES			
No lubrication required.	-	-	-
SYNCHRO LINE AMPLIFIERS			
No lubrication required.	-	-	-
ACTIVE ACQUISITION AID			
Elevation Drive Assembly	Add oil as needed. Refer to equipment manual.	High grade SAE 10 nondetergent lubricating oil.	Monthly
Azimuth Drive Assembly	Drain water from sump and add oil as needed. Refer to equipment manual.	High grade SAE 10 nondetergent lubricating oil.	Weekly
Antenna Control Unit	Clean and re-lubricate gears. Refer to equipment manual.	High grade SAE 10 nondetergent lubricating oil and lubriplate.	As required
Muffin fans in RF Housing	Lubricate with one or two drops of oil. Refer to equipment manual.	Aero Shell No. 12 (MIL-L-6085)	Monthly
SYNCHRO REMOTING TRANSMITTER-RECEIVERS			
Azimuth and elevation servo encoder assembly gear trains	Grease gears. Refer to equipment manual.	High grade cup grease such as MIL-G-3278A or ANG-25.	Semi-Annually

TABLE 5-V. TEST EQUIPMENT APPLICATIONS

Equipment	Manufacturer	Model	Application
Oscilloscope	Hewlett-Packard Company	130B	General waveform observation and voltage measurements.
Oscilloscope	Tektronix, Incorporated	545A	General waveform observation and voltage measurements.
Wide-Band, High-Gain Calibrated Preamp	Tektronix, Incorporated	Type B	Oscilloscope plug-in unit used with Tektronix 545A.
Dual-Trace Calibrated Preamp	Tektronix, Incorporated	Type CA	Oscilloscope plug-in unit used with Tektronix 545A.
Plug-In Preamplifier	Tektronix, Incorporated	Type L	Oscilloscope plug-in unit used with Tektronix 545A.
Viewing Hood	Tektronix, Incorporated	H510	Aid in viewing of oscilloscope screens.
Oscilloscope Cart	Technibilt Corporation	OC-2 (Bendix Radio Part-A683940-2)	Support and transportation of oscilloscopes.
Oscilloscope Cart	Technibilt Corporation	OC-2 (Bendix Radio Part-A683940-1)	Support and transportation of oscilloscopes and storage of plug-in units.
Unit Regulated Power Supply	General Radio Company	1201-B	General bench testing of assemblies. Provides a source of a-c heater voltage at 6.3 VAC and 4A, and d-c plate power at 300 VDC and 70 ma.
Regulated Power Supply	Lambda Electronics Corporation	71	General purpose power supply with following outputs; 0-500 VDC, 0-200 ma; 0-200 VDC, 0-50 VDC, Bias; and 6.5 VAC, 5A.
DC Power Supply	John Fluke Manufacturing Company, Incorporated	407	High resolution power supply with output of 0 to 555 volts and 0 to 300 ma for calibration purposes.

TABLE 5-V. TEST EQUIPMENT APPLICATIONS (Cont.)

Equipment	Manufacturer	Model	Application
Square Wave Generator	Tektronix, Incorporated	Type 105	Alignment and testing of oscilloscopes and associated plug-in units.
Signal Generator	Boonton Radio Corporation	225-A	Test and alignment of receivers, sensitivity and bandwidth measurements in the 10- to 500-MC frequency range.
Sweep Generator	Telonic Industries, Incorporated	HN-3	Testing and adjusting r-f circuits in the frequency range of 0.5 to 300 MC.
HF Signal Generator	Hewlett-Packard Company	606-A	General purpose signal generator with a frequency range of 50 KC to 65 MC.
Function Generator	Hewlett-Packard Company	202-A	Test and adjustment of circuits which handle non-sinusoidal waveshapes.
Transfer Oscillator	Hewlett-Packard Company	540-B	Test and alignment of signal generators up to 2000 MC.
Wide Range Oscillator	Hewlett-Packard Company	200 CD	Test and adjustment of circuits in the range of 5 CPS to 600 KC.
Unit Oscillator	General Radio Company	1209-BL	Test and alignment of receivers, sensitivity and bandwidth measurements in the 180- to 600-MC range.
Universal EPUT and Timer	Beckman Instruments, Incorporated	7370	Precision frequency measurements from 10 CPS to 11.5 MC.
Frequency Converter	Beckman Instruments, Incorporated	7570 through 7573	Used with Beckman EPUT and timer to measure frequencies up to 220 MC.
Field Strength Meter	Empire Devices Products Corporation	NF-105 (Bendix Part No. A683351)	Noise figure measurements in the 150-KC to 400-MC frequency range.

TABLE 5-V. TEST EQUIPMENT APPLICATIONS (Cont.)

Equipment	Manufacturer	Model	Application
Power Output Meter	The Daven Company	OP-962	Audio frequency power measurements in the power range of 0.1 milliwatt to 100 watts.
Potentiometric DC Voltmeter	John Fluke Manufacturing Company, Incorporated	801	Precision d-c measurements with .05 per cent accuracy over the range of .01 to 500 volts.
Vacuum Tube Volt-meter	Hewlett-Packard Company	410B	General a-c, d-c and r-f voltage measurements and resistance measurements.
Vacuum Tube Volt-meter	Hewlett-Packard Company	400D	Accurate a-c voltage measurements from .001 volt to 300 volts over a frequency range of 10 cycles to 4 megacycles.
Volt-Ohm-Milliammeter	Triplett-Electrical Instrument Company	630-PL	General voltage, current and resistance measurements, (20,000 ohm/volt).
Noise and Distortion Analyzer	Hewlett-Packard Company	330B	Measure total distortion of any frequency from 20 to 20,000 CPS.
RF Detector	Telonic Industries, Incorporated	XD-3	Detect output of r-f preamplifiers and i-f amplifiers in the 0.5- to 1000-MC range.
Tube Analyzer	Triplett Electrical Instrument Company	3444	Tube checks.
Variac	General Radio Company	W10MT	General purpose voltage source with output of 0-115 VAC at 10 amps.
Attenuator Pad	Telonic Industries, Incorporated	TGC-50	Matching, isolation and general bench test applications in the 0.5- to 1000-MC frequency range.
Miscellaneous Cables and Accessories	-	-	-